FCC / ISED RF Test Report

Report No.:	FCC_IC_RF_SL20010901-HAR-2219_2.4G
FCC ID:	2AHPN-BE2846
IC:	6434C-BE2846
Model:	R1 EXT NA
Received Date:	02/10/2020
Test Date:	02/18/2020 – 02/29/2020
Issued Date:	03/20/2020
Applicant:	HARMAN INTERNATIONAL
Address:	30001 Cabot Drive, Novi, MI 48377, USA
Manufacturer:	HARMAN INTERNATIONAL
Address:	30001 Cabot Drive, Novi, MI 48377, USA
Issued By:	Bureau Veritas Consumer Products Services, Inc.
Lab Address:	775 Montague Expressway, Milpitas, CA 95035
FCC Registration / IC Designation Number:	540430 / 4842D

ACCREDITED
TESTING CERT # 2742-01

Table of Contents

Release Control Record

Issue No.	Description	Date Issued
FCC_IC_RF_SL20010901-HAR-2220_2.4G	Orignal Release	03/20/2020

1 Certificate of Conformity

Product:	Automotive Infotainment Unit
Brand:	HARMAN
Model:	R1 EXT NA
Sample Status:	Engineering sample
Applicant:	Harman International
Test Date:	02/18/2020 – 02/29/2020
Standards:	47 CFR FCC Part 15, Subpart C (Section 15.247) RSS 247 Issue 2, February 2017 ANSI C63.10: 2013 RSS Gen Issue 5, March 2019 KDB 558074 D01 15.247 Meas Guidance v05r02

The above equipment has been tested by **Bureau Veritas Consumer Products Services, Inc., Milpitas Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : _____ , **Date:** *03/18/2019*

Yao-Wei Lee / Test Engineer

Approved by : _____ , **Date:** *03/19/2020*

Chen Ge / Engineer Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.247) / ISED RSS-247				
FCC Clause	RSS Section(s)	Test Item	Result	Remarks
15.207	RSS-Gen [8.8]	AC Power Conducted Emission	N/A	N/A
15.205 &15.209 & 15.247(d)	RSS-Gen [8.9] RSS-247 [5.5]	Radiated Emissions and Band Edge Measurement	PASS	Meet the requirement of limit.
15.247(d)	RSS-247[5.5]	Antenna Port Emission	PASS	Meet the requirement of limit.
15.247(a)(2)	RSS-247[5.2]	6dB Bandwidth & 99% Bandwidth	PASS	Meet the requirement of limit.
15.247(b)	RSS-247 [5.4(4)]	Conducted power	PASS	Meet the requirement of limit.
15.247(e)	RSS-247 [5.2)]	Power Spectral Density	PASS	Meet the requirement of limit.
15.203		Antenna Requirement	PASS	Antenna connector is FAKRA. (The device is professionally installed)

Note: The EUT is DC powered.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.51dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	3.73dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	4.64dB
	6GHz ~ 18GHz	4.82dB
	18GHz ~ 40GHz	4.91dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Automotive Infotainment Unit
Brand	Harman International
Test Model	R1 EXT NA
Status of EUT	Engineering sample
Power Supply Rating	12V, 20A
Modulation Type	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM
Modulation Technology	DSSS, OFDM
Transfer Rate	802.11b: up to 11Mbps 802.11g: up to 54Mbps 802.11n: up to 300Mbps
Operating Frequency	2412~2462MHz
Number of Channel	11 for 802.11b, 802.11g, 802.11n(HT20)
Output Power	14.28mW
Antenna Type	External PCB Antenna, 1.43dBi
Antenna Connector	FAKRA

3.2 Description of Test Modes

11 channels are provided for 802.11b, 802.11g and 802.11n (HT20):

Channel	Frequency	Channel	Frequency
1	2412MHz	7	2442MHz
2	2417MHz	8	2447MHz
3	2422MHz	9	2452MHz
4	2427MHz	10	2457MHz
5	2432MHz	11	2462MHz
6	2437MHz		

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE≥1G	RE<1G	PLC	APCM	
-	√	√	N/A	√	-

Where RE≥1G: Radiated Emission above 1GHz & Bandedge Measurement
RE<1G: Radiated Emission below 1GHz
PLC: Power Line Conducted Emission
APCM: Antenna Port Conducted Measurement

NOTE: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Y-plane**.
NOTE: "-" means no effect.

Radiated Emission Test (Above 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6
-	802.11n (HT20)	1 to 11	1, 6, 11	OFDM	BPSK	6.5

Radiated Emission Test (Below 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11n (20MHz)	1 to 11	6	OFDM	BPSK	6.5

Power Line Conducted Emission Test:

☐ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☐ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11n (HT20)	1 to 11	6	OFDM	BPSK	6.5

Antenna Port Conducted Measurement:

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6
-	802.11n (HT20)	1 to 11	1, 6, 11	OFDM	BPSK	6.5

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	25deg. C, 65%RH	120Vac, 60Hz	Yao Wei Lee
RE<1G	25deg. C, 65%RH	120Vac, 60Hz	Yao Wei Lee
PLC	25deg. C, 68%RH	120Vac, 60Hz	Yao Wei Lee
APCM	21deg. C, 60%RH	120Vac, 60Hz	Yao Wei Lee

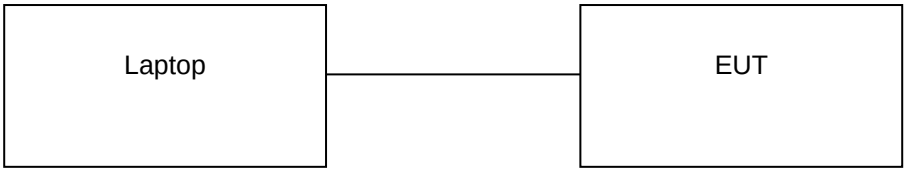
3.3 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	Dell	Latitude 3550	2MHWY32	N/A	Provided by Lab

Note: The core(s) is (are) originally attached to the cable(s).

3.3.1 Configuration of System under Test



3.4 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

47 CFR FCC Part 15, Subpart C (Section 15.247)
RSS 247 Issue2, February 2017
ANSI C63.10: 2013
RSS Gen Issue5, March 2019
558074 D01 15.247 Meas Guidance v05r02

All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
EMI Receiver	ESW 44	1328.4100K-101662-MH	08/30/2019	08/30/2020
Biconilog Antenna Sunol	JB1	A030702	03/09/2018	03/09/2020
Pre-Amplifier RF Bay, Inc.	LPA-6-30	11170601	04/27/2019	04/27/2020
Horn Antenna ETS-Lindgren	3117	218554	11/22/2019	11/22/2020
Pre-Amplifier RF-Lambda	RAMP00M50GA	17032300048	06/18/2019	06/18/2020

4.1.3 Test Procedures

For Radiated emission below 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

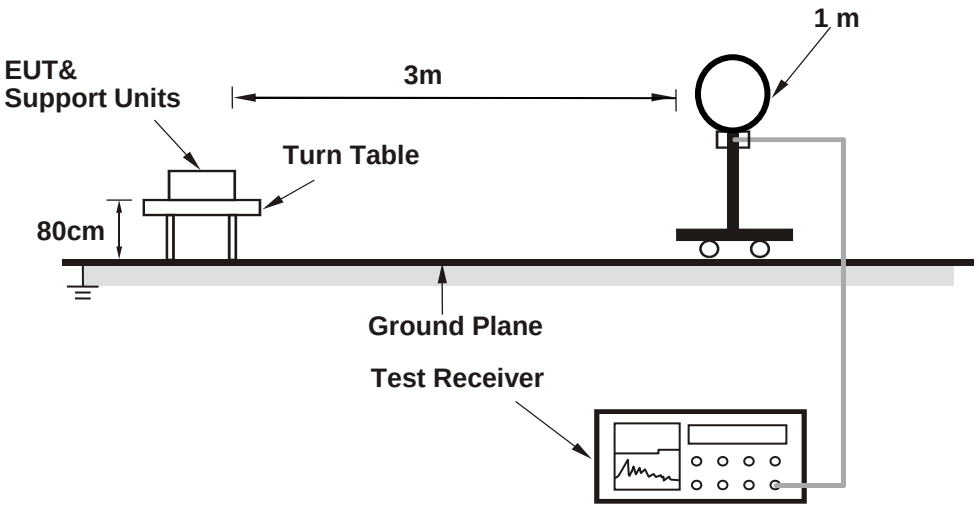
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

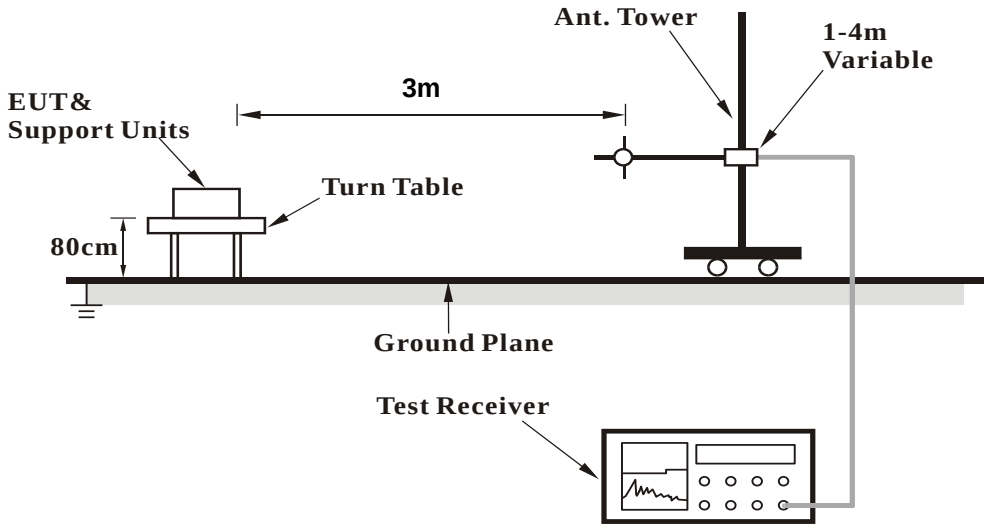
No deviation.

4.1.5 Test Setup

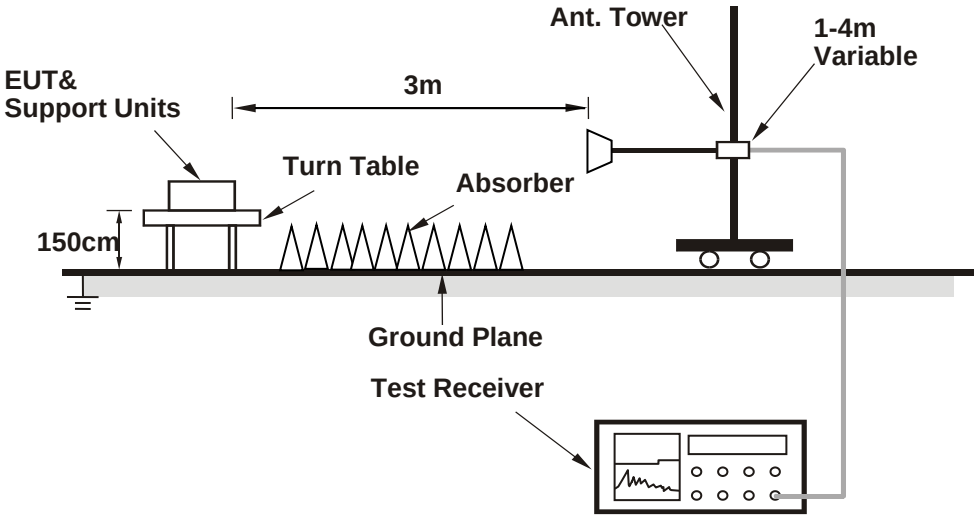
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

a. Connected the EUT with the Notebook Computer which is placed on remote site.
b. Controlling software has been activated to set the EUT on specific status.

4.1.7 Test Results

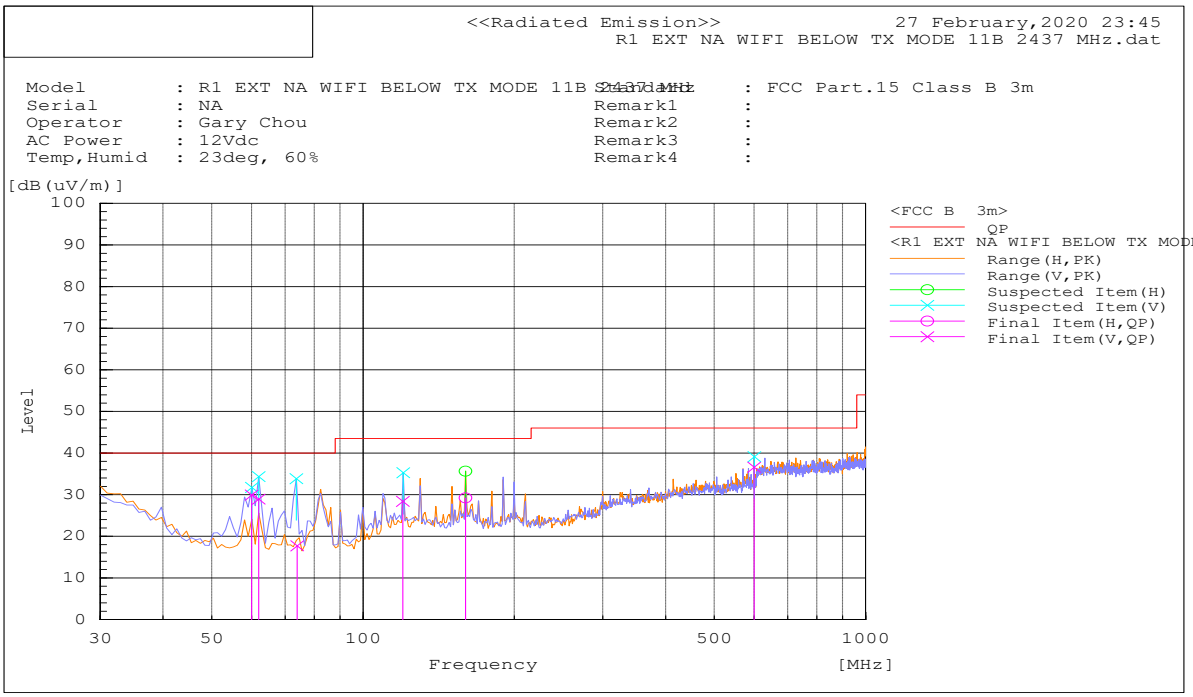
BELOW 1GHz WORST-CASE DATA:

CHANNEL	802.11n Channel 6	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	60.023	V	17.2	12.7	29.9	40	-10.1	100	28.1	Pass
2	62.018	V	16.2	12.7	28.9	40	-11.1	104	347.3	Pass
3	73.96	V	4.7	13	17.7	40	-22.3	100	61	Pass
4	120.006	V	8.7	19.7	28.4	43.5	-15.1	100	227.4	Pass
5	160.001	H	10.9	18.3	29.2	43.5	-14.3	129	299.9	Pass
6	600.003	V	11.1	25.5	36.6	46	-9.4	100	61.2	Pass

REMARKS:

1. Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.



ABOVE 1GHz TEST DATA:

WLAN 2.4GHz

802.11b

Above 1GHz-25GHz – 802.11b – 2412MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4823.973	H	49.5	-2.7	Average	46.8	54	-7.2	116.8	95.8
7237.001	H	33.7	4.5	Average	38.2	54	-15.8	161.4	104.4
9648.163	H	29	9.9	Average	38.9	54	-15.1	113.3	279
4823.973	H	52.7	-2.7	Peak	50	74	-24	116.8	95.8
7237.001	H	42.7	4.5	Peak	47.2	74	-26.8	161.4	104.4
9648.163	H	38.5	9.9	Peak	48.4	74	-25.6	113.3	279

Above 1GHz-25GHz- 802.11b - 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4874.06	H	50	-2.6	Average	47.4	54	-6.6	109.7	79.3
7310.407	H	36.1	4.3	Average	40.4	54	-13.6	134.8	2.9
9748.581	H	29.1	10.1	Average	39.2	54	-14.8	242.4	321.3
4874.06	H	53.3	-2.6	Peak	50.7	74	-23.3	109.7	79.3
7310.407	H	44.1	4.3	Peak	48.4	74	-25.6	134.8	2.9
9748.581	H	38.4	10.1	Peak	48.5	74	-25.5	242.4	321.3

Above 1GHz-25GHz – 802.11b – 2462MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4923.971	H	49.8	-2.6	Average	47.2	54	-6.8	184.2	74.1
7386.78	H	38.9	4.1	Average	43	54	-11	154.7	359.9
9848.956	H	29.2	10.2	Average	39.4	54	-14.6	307.6	86.8
4923.971	H	52.9	-2.6	Peak	50.3	74	-23.7	184.2	74.1
7386.78	H	44.9	4.1	Peak	49	74	-25	154.7	359.9
9848.956	H	38.7	10.2	Peak	48.9	74	-25.1	307.6	86.8

802.11g

Above 1GHz-25GHz- 802.11g - 2412MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4825.339	H	38.9	-2.7	Average	36.2	54	-17.8	192.3	39.9
7235.267	H	34	4.5	Average	38.5	54	-15.5	150	92.5
9648.18	H	30.1	9.9	Average	40	54	-14	102.2	358.2
4825.339	H	48.6	-2.7	Peak	45.9	74	-28.1	192.3	39.9
7235.267	H	44.5	4.5	Peak	49	74	-25	150	92.5
9648.18	H	39.7	9.9	Peak	49.6	74	-24.4	102.2	358.2

Above 1GHz-25GHz – 802.11g – 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4874.649	H	41.5	-2.6	Average	38.9	54	-15.1	270.2	92.6
7311.593	H	33.1	4.3	Average	37.4	54	-16.6	129.2	159.8
9747.96	H	28.8	10.1	Average	38.9	54	-15.1	235.1	70.6
4874.649	H	52.7	-2.6	Peak	50.1	74	-23.9	270.2	92.6
7311.593	H	42.8	4.3	Peak	47.1	74	-26.9	129.2	159.8
9747.96	H	39.3	10.1	Peak	49.4	74	-24.6	235.1	70.6

Above 1GHz-25GHz- 802.11g - 2462MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4924.948	H	39.1	-2.6	Average	36.5	54	-17.5	294.4	92
7385.555	H	35.3	4.1	Average	39.4	54	-14.6	146.9	357.5
9848.154	H	29.8	10.2	Average	40	54	-14	100.8	121.8
4924.948	H	49.2	-2.6	Peak	46.6	74	-27.4	294.4	92
7385.555	H	44.8	4.1	Peak	48.9	74	-25.1	146.9	357.5
9848.154	H	38.4	10.2	Peak	48.6	74	-25.4	100.8	121.8

802.11n-HT20

Above 1GHz-25GHz- 802.11n20 - 2412MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4824.188	H	40.1	-2.7	Average	37.4	54	-16.6	190.5	94.8
7235.225	H	34.2	4.5	Average	38.7	54	-15.3	165.6	352.7
9648.571	H	28.4	9.9	Average	38.3	54	-15.7	126.1	208.9
4824.188	H	51.2	-2.7	Peak	48.5	74	-25.5	190.5	94.8
7235.225	H	43.6	4.5	Peak	48.1	74	-25.9	165.6	352.7
9648.571	H	38.1	9.9	Peak	48	74	-26	126.1	208.9

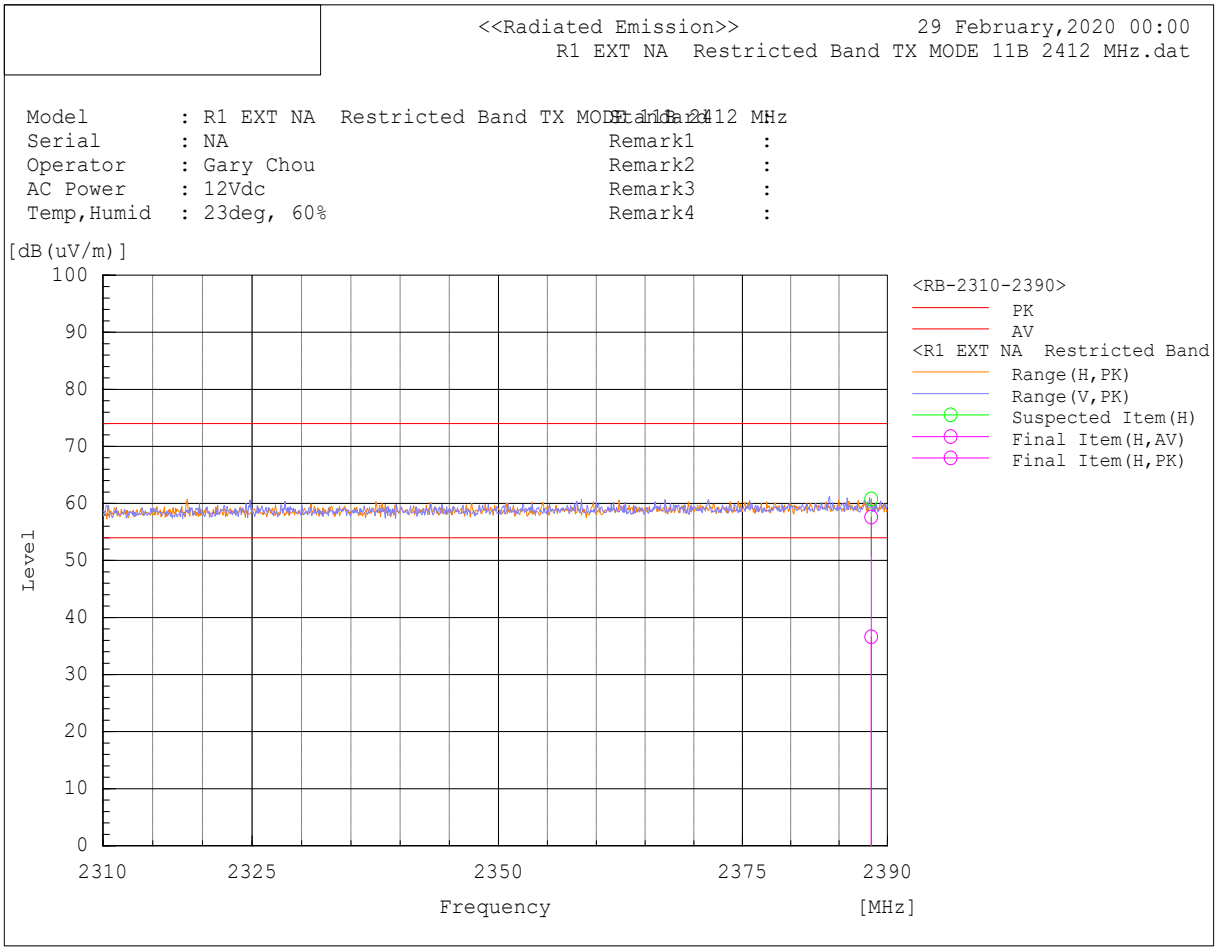
Above 1GHz-25GHz – 802.11n20 – 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4875.186	H	41.5	-2.6	Average	38.9	54	-15.1	104	90
7311.825	H	34	4.3	Average	38.3	54	-15.7	132.6	352.7
9748.083	H	29	10.1	Average	39.1	54	-14.9	128.6	84
4875.186	H	53.6	-2.6	Peak	51	74	-23	104	90
7311.825	H	44.1	4.3	Peak	48.4	74	-25.6	132.6	352.7
9748.083	H	38.4	10.1	Peak	48.5	74	-25.5	128.6	84

Above 1GHz-25GHz- 802.11n20 - 2462MHz

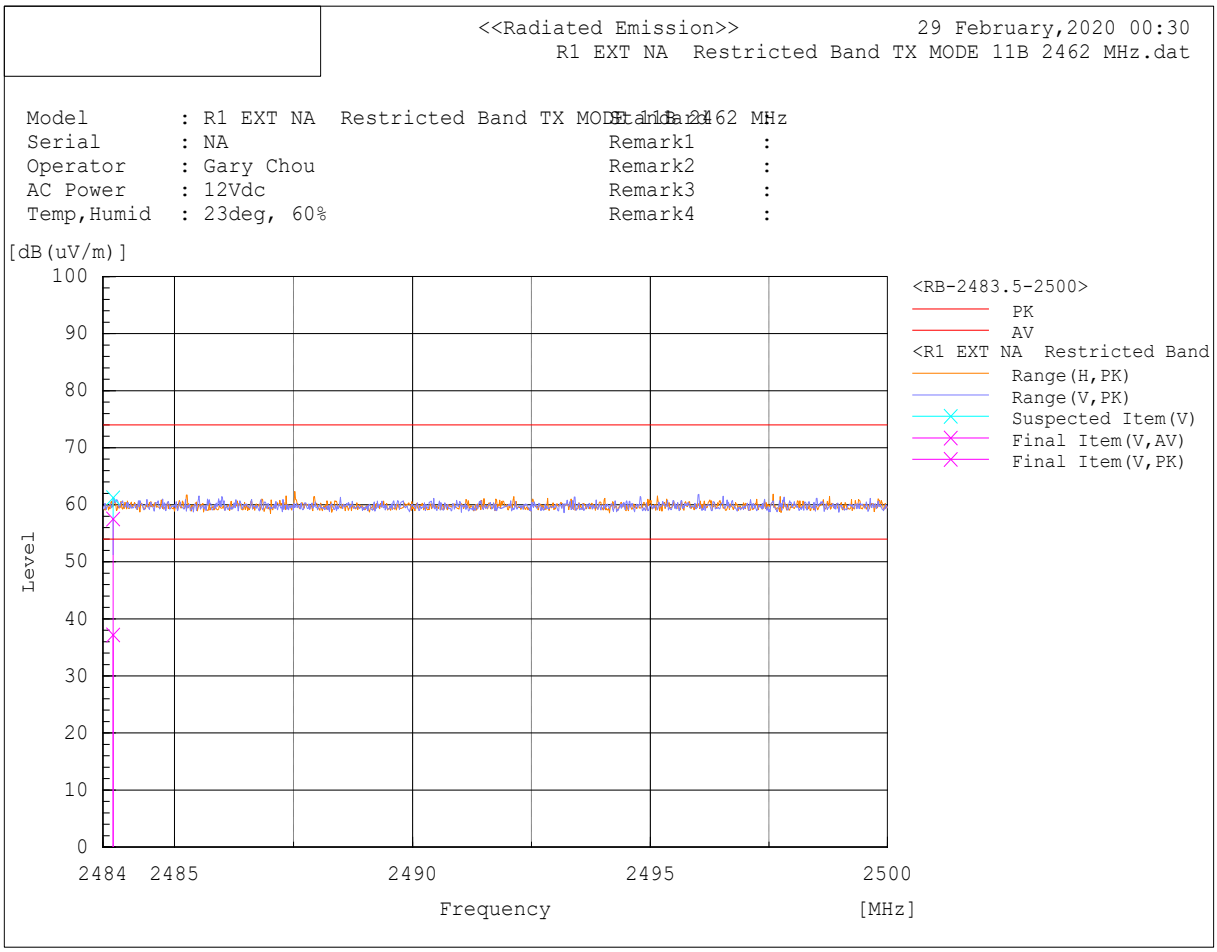
ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4923.501	H	37	-2.6	Average	34.4	54	-19.6	382.7	161.6
7386.946	H	36	4.1	Average	40.1	54	-13.9	139.8	357.8
9848.275	H	29.3	10.2	Average	39.5	54	-14.5	241.7	58.6
4923.501	H	47	-2.6	Peak	44.4	74	-29.6	382.7	161.6
7386.946	H	46.6	4.1	Peak	50.7	74	-23.3	139.8	357.8
9848.275	H	39.2	10.2	Peak	49.4	74	-24.6	241.7	58.6

RESTRICTED BAND (802.11b LOW CHANNEL)



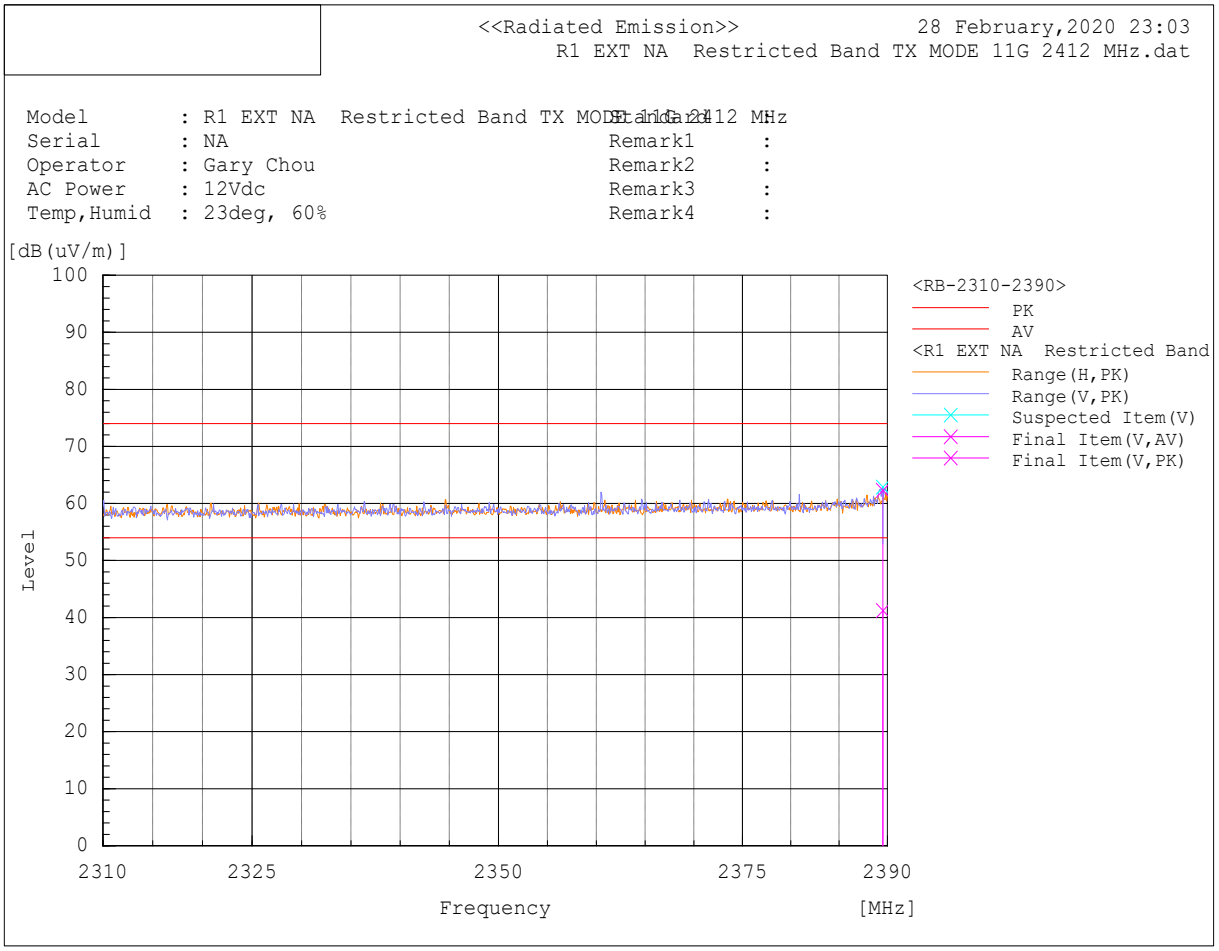
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2388.32	H	1.5	Average	35.1	36.6	54	-17.4	273	308.8
2388.32	H	22.5	Peak	35.1	57.6	74	-16.4	273	308.8

RESTRICTED BAND (802.11b High CHANNEL)



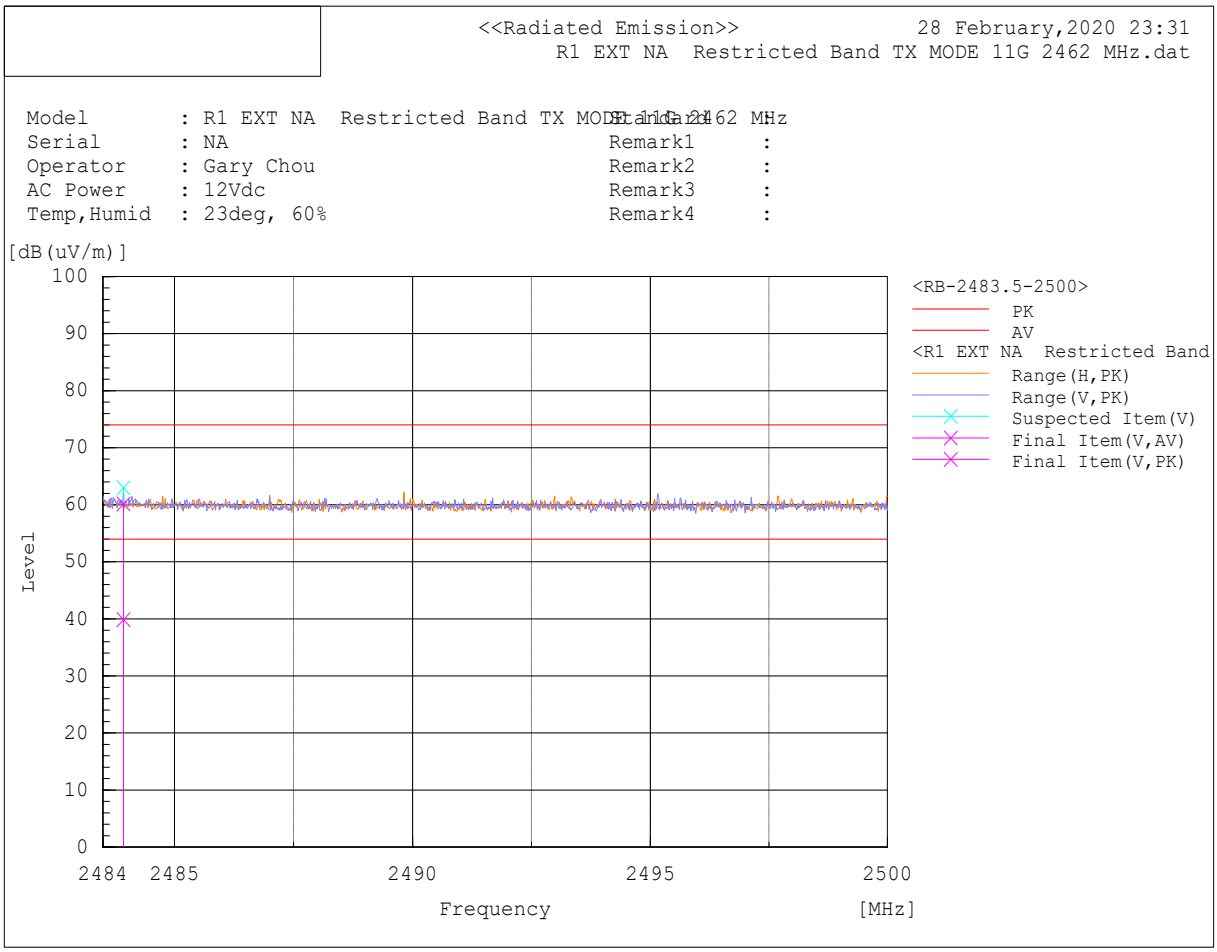
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2483.715	V	1.6	Average	35.6	37.2	54	-16.8	349	18.7
2483.715	V	21.9	Peak	35.6	57.5	74	-16.5	349	18.7

RESTRICTED BAND (802.11g LOW CHANNEL)



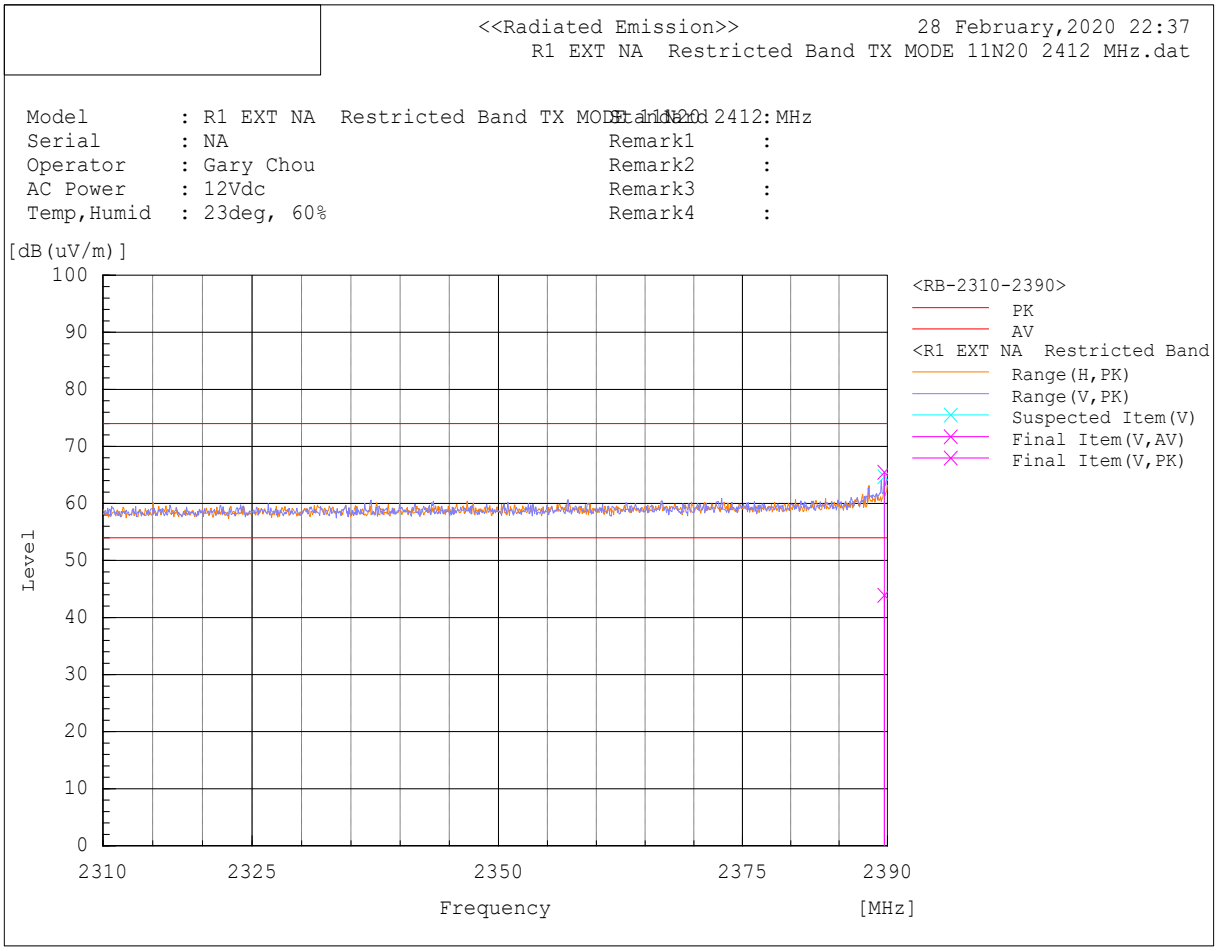
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2389.52	V	6.1	Average	35.1	41.2	54	-12.8	307	15.9
2389.52	V	27.2	Peak	35.1	62.3	74	-11.7	307	15.9

RESTRICTED BAND (802.11g High CHANNEL)



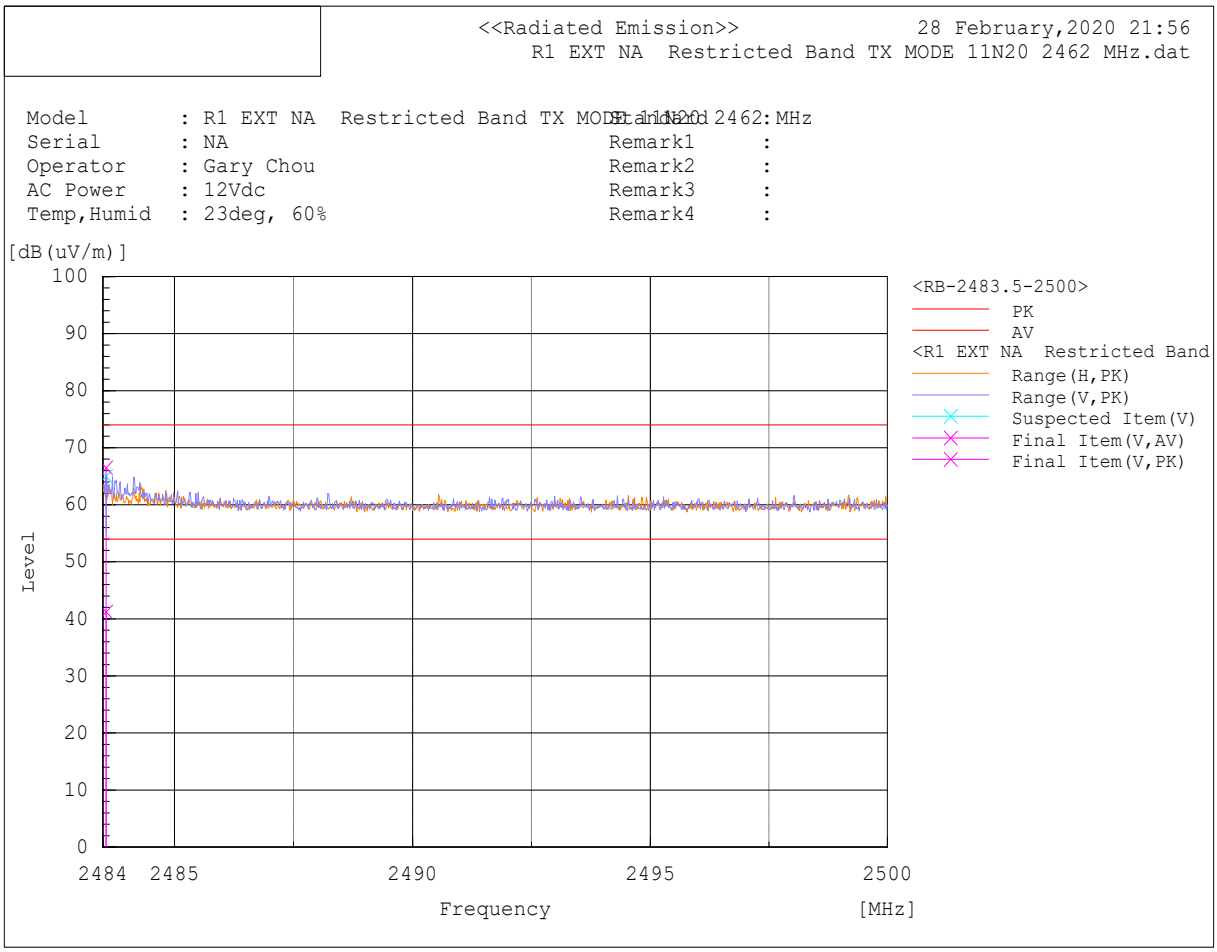
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2483.929	V	4.3	Average	35.6	39.9	54	-14.1	146	0
2483.929	V	24.6	Peak	35.6	60.2	74	-13.8	146	0

RESTRICTED BAND (802.11n LOW CHANNEL)



Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2389.68	V	8.8	Average	35.1	43.9	54	-10.1	154	359.9
2389.68	V	30.4	Peak	35.1	65.5	74	-8.5	154	359.9

RESTRICTED BAND (802.11n High CHANNEL)



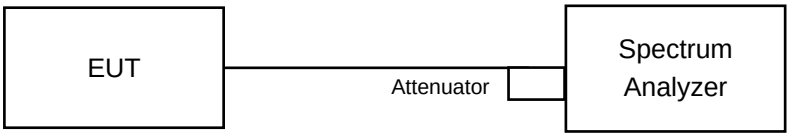
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2483.566	V	5.6	Average	35.6	41.2	54	-12.8	213	0
2483.566	V	30.9	Peak	35.6	66.5	74	-7.5	213	0

4.2 6dB Bandwidth & 99% Bandwidth Measurement

4.2.1 Limits of 6dB Bandwidth Measurement

The minimum of 6dB Bandwidth Measurement is 0.5 MHz.

4.2.2 Test Setup



4.2.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.2.4 Test Procedure

a. Set resolution bandwidth (RBW) = 100kHz
b. Set the video bandwidth (VBW) ≥ 3 x RBW, Detector = Peak.
c. Trace mode = max hold.
d. Sweep = auto couple.
e. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

4.2.5 Deviation fromTest Standard

No deviation.

4.2.6 EUT Operating Conditions

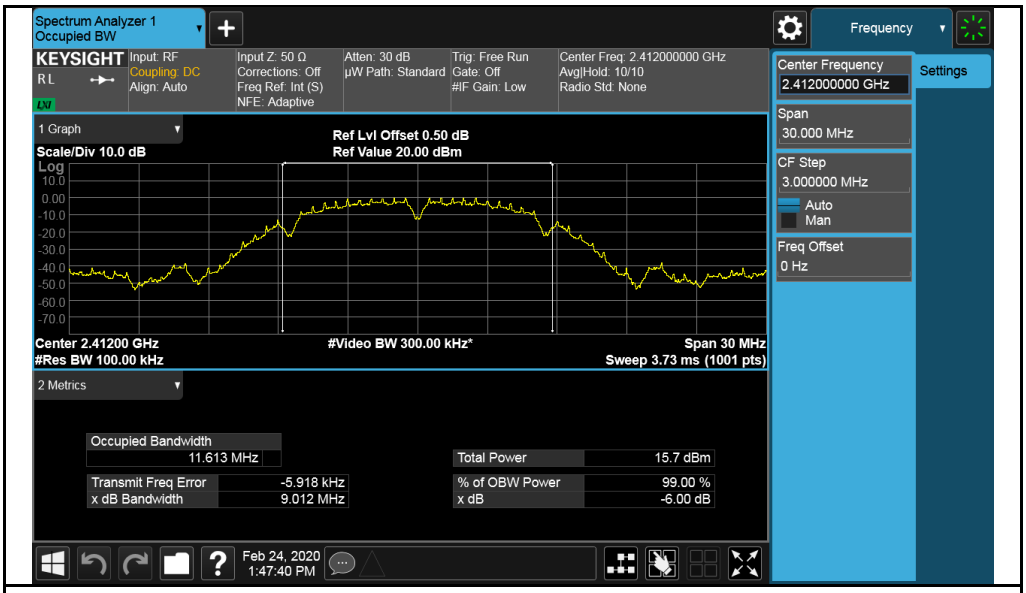
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.2.7 Test Result

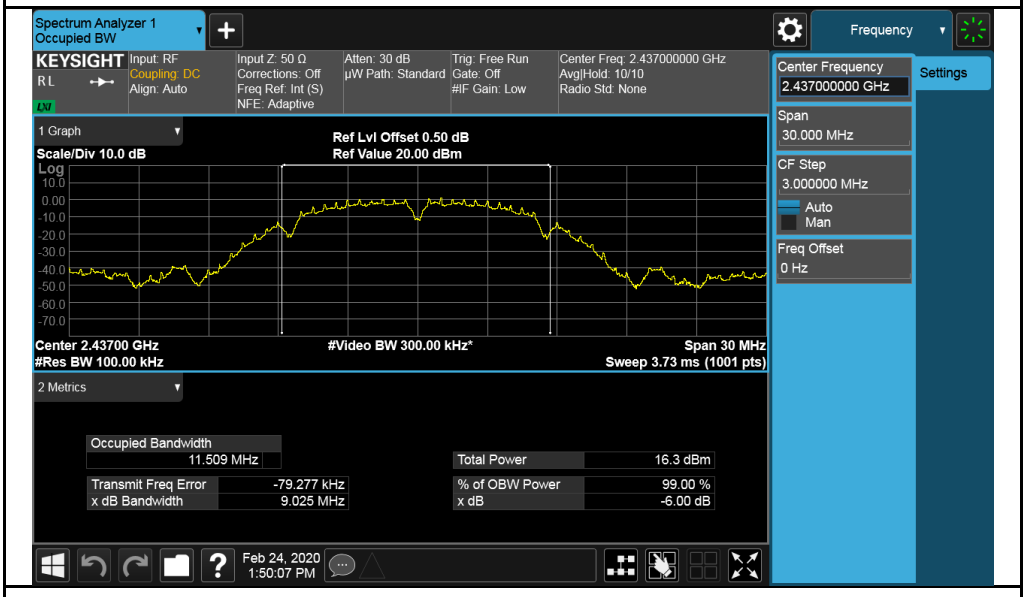
802.11b

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth	Minimum Limit (MHz)	Pass / Fail
1	2412	9.014	11.613	0.5	PASS
6	2437	9.025	11.509	0.5	PASS
11	2462	8.090	11.072	0.5	PASS

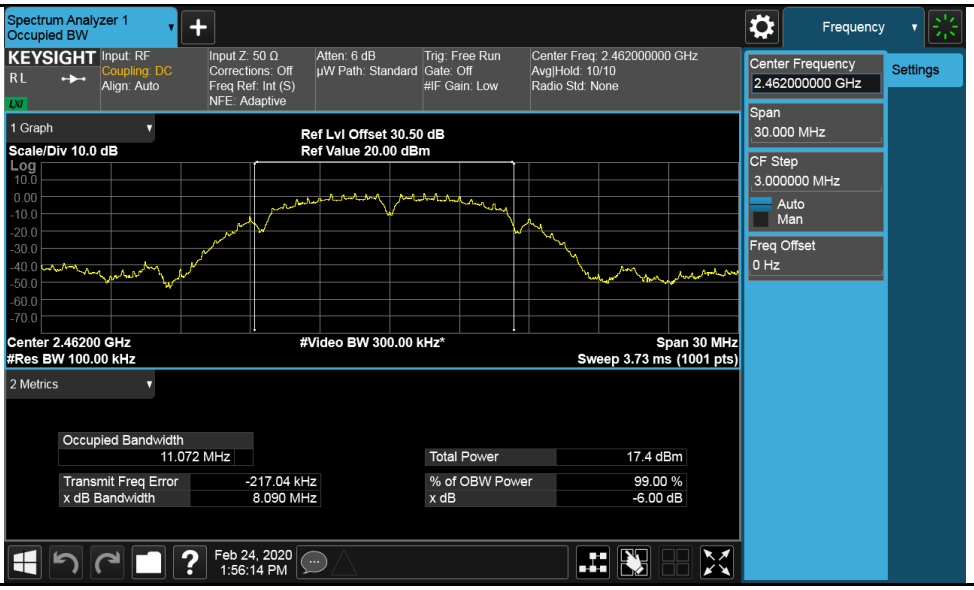
Test Plots:



2412MHz



2437MHz

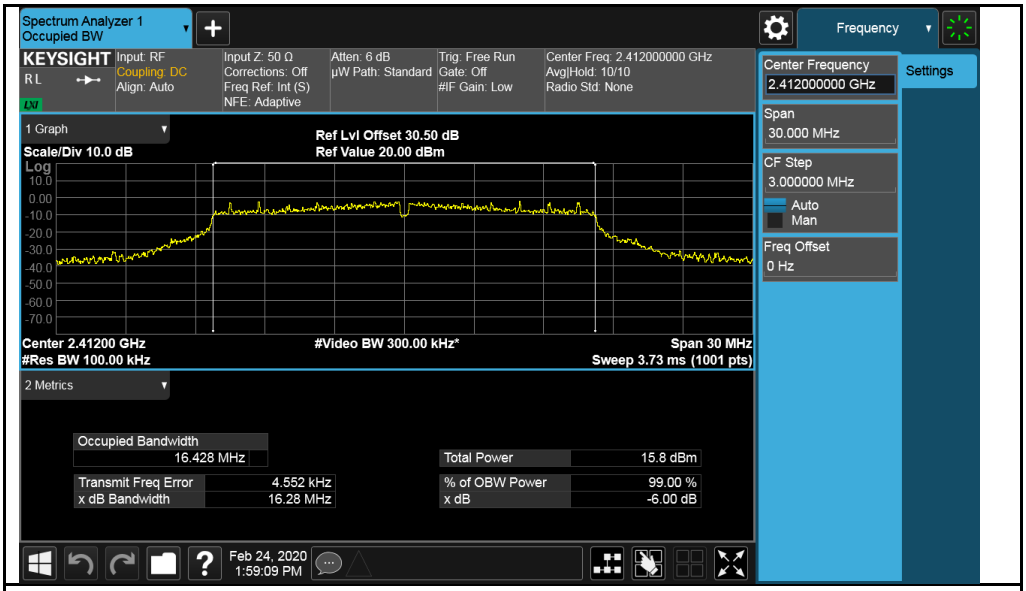

Spectrum Analyzer 1
Occupied BW
Frequency
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold: 10/10
Radio Std: None
Center Frequency
2.462000000 GHz
Settings
Span
30.000 MHz
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 30.50 dB
Scale/Div 10.0 dB
Ref Value 20.00 dBm
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.46200 GHz
#Res BW 100.00 kHz
#Video BW 300.00 kHz*
Span 30 MHz
Sweep 3.73 ms (1001 pts)
2 Metrics
Occupied Bandwidth
11.072 MHz
Total Power
17.4 dBm
Transmit Freq Error
-217.04 kHz
% of OBW Power
99.00 %
x dB Bandwidth
8.090 MHz
x dB
-6.00 dB
Feb 24, 2020
1:56:14 PM

2462MHz

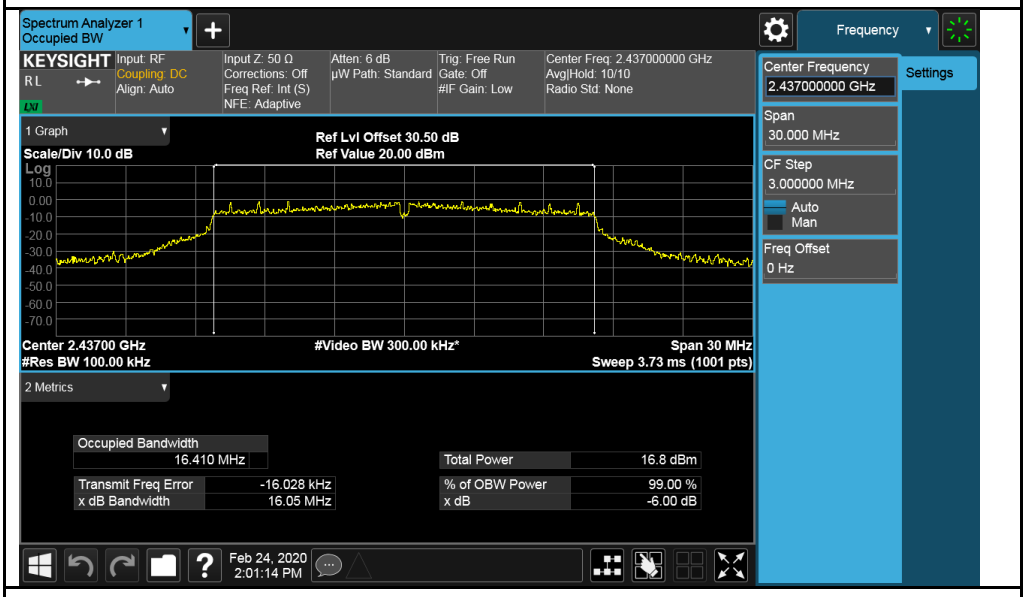
802.11g

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth	Minimum Limit (MHz)	Pass / Fail
1	2412	16.280	16.428	0.5	PASS
6	2437	16.050	16.410	0.5	PASS
11	2462	16.300	16.400	0.5	PASS

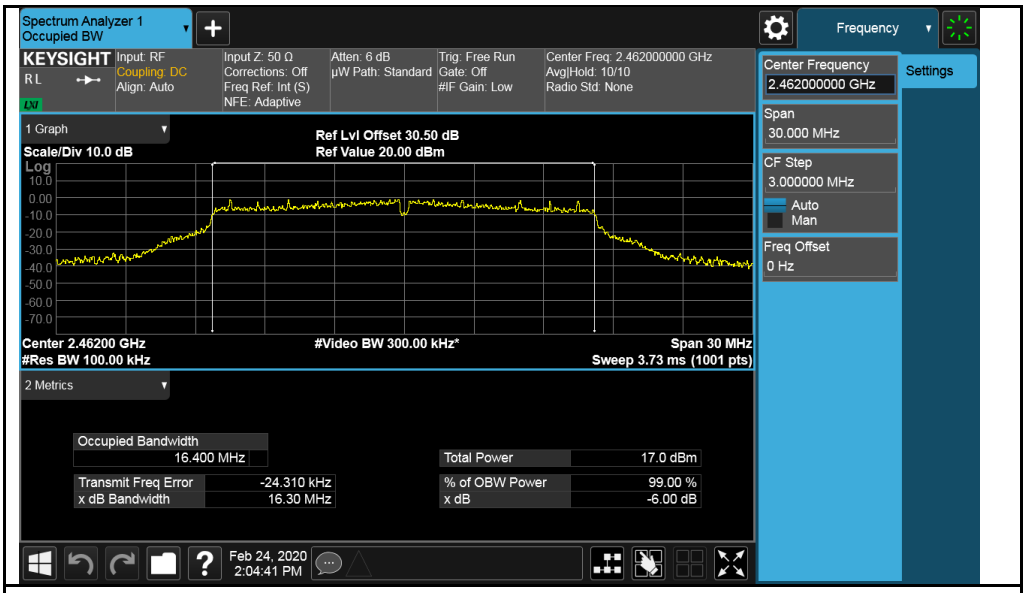
Test Plots:



2412MHz



2437MHz

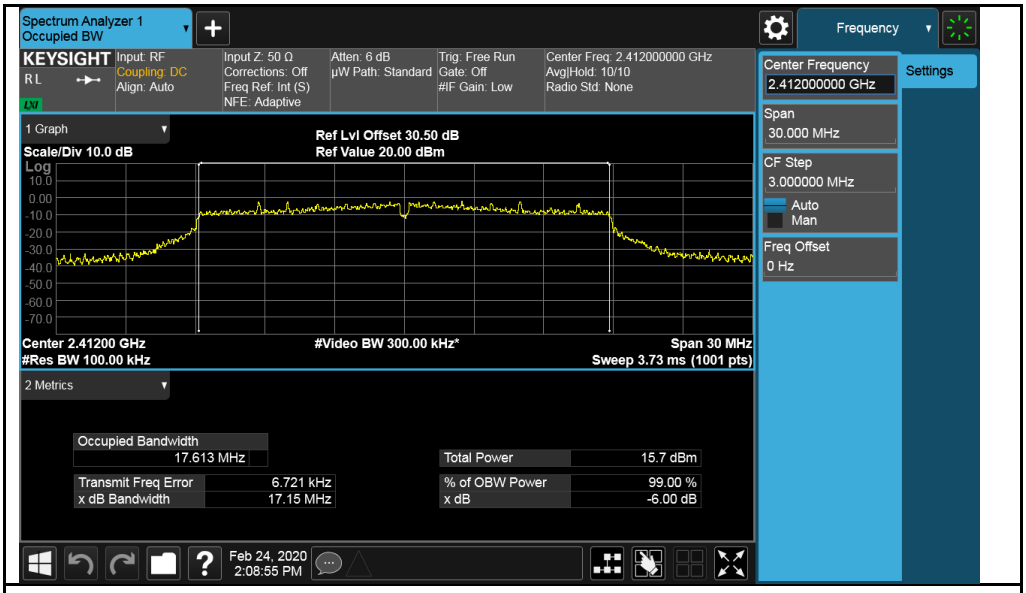

Spectrum Analyzer 1
Occupied BW
KEYSIGHT
RL
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold: 10/10
Radio Std: None
Frequency
Center Frequency
2.462000000 GHz
Settings
Span
30.000 MHz
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 30.50 dB
Scale/Div 10.0 dB
Ref Value 20.00 dBm
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.46200 GHz
#Res BW 100.00 kHz
#Video BW 300.00 kHz*
Span 30 MHz
Sweep 3.73 ms (1001 pts)
2 Metrics
Occupied Bandwidth
16.400 MHz
Total Power
17.0 dBm
Transmit Freq Error
-24.310 kHz
% of OBW Power
99.00 %
x dB Bandwidth
16.30 MHz
x dB
-6.00 dB
Feb 24, 2020
2:04:41 PM

2462MHz

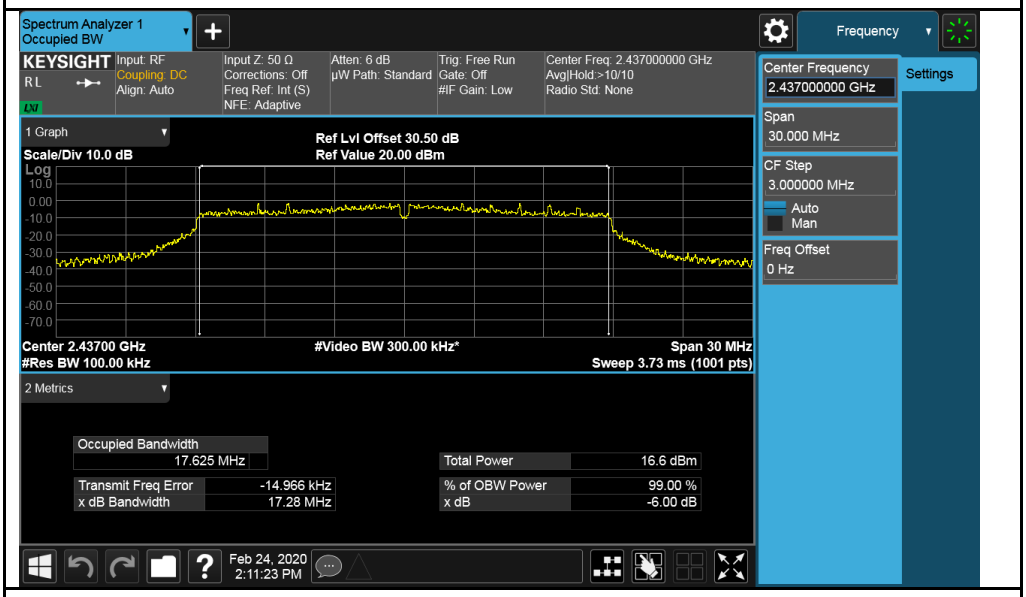
802.11n-HT20

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth	Minimum Limit (MHz)	Pass / Fail
1	2412	17.150	17.613	0.5	PASS
6	2437	17.280	17.625	0.5	PASS
11	2462	17.160	17.614	0.5	PASS

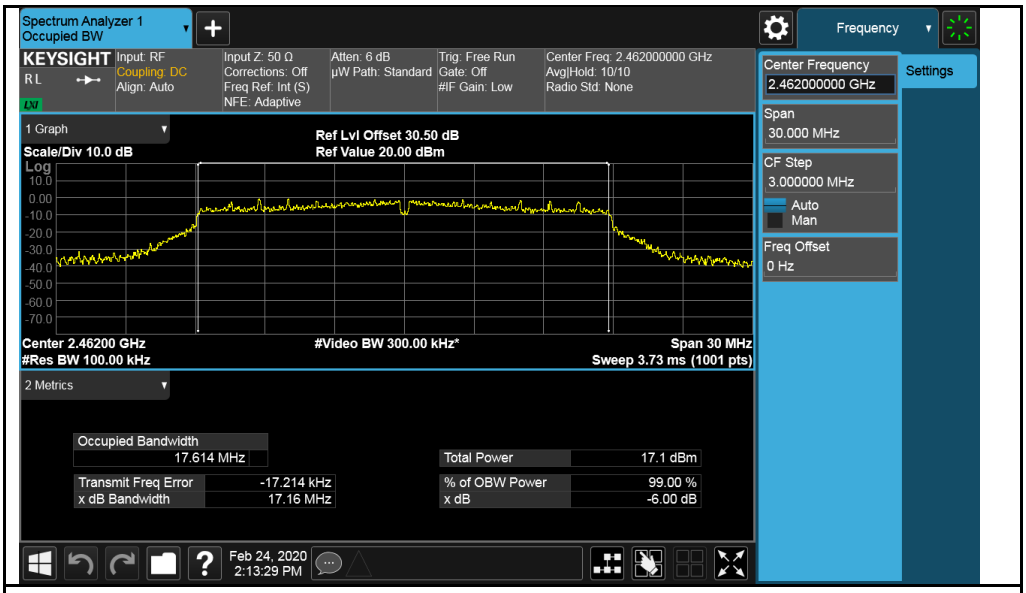
Test Plots:



2412MHz



2437MHz


Spectrum Analyzer 1
Occupied BW
KEYSIGHT
RL
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold: 10/10
Radio Std: None
Frequency
Center Frequency
2.462000000 GHz
Settings
Span
30.000 MHz
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 30.50 dB
Ref Value 20.00 dBm
Scale/Div 10.0 dB
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.46200 GHz
#Res BW 100.00 kHz
#Video BW 300.00 kHz*
Span 30 MHz
Sweep 3.73 ms (1001 pts)
2 Metrics
Occupied Bandwidth
17.614 MHz
Total Power
17.1 dBm
Transmit Freq Error
-17.214 kHz
% of OBW Power
99.00 %
x dB Bandwidth
17.16 MHz
x dB
-6.00 dB
Feb 24, 2020
2:13:29 PM

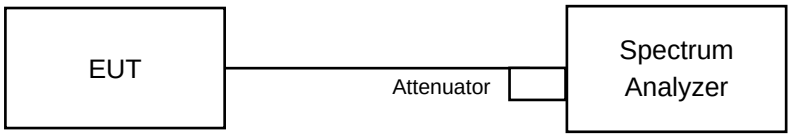
2462MHz

4.3 Conducted Output Power Measurement

4.3.1 Limits of Conducted Output Power Measurement

For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt (30dBm)

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedures

a. Set the RBW ≥ DTS bandwidth.
b. Set VBW ≥ 3 × RBW.
c. Set span ≥ 3 x RBW
d. Sweep time = auto couple.
e. Detector = peak.
f. Trace mode = max hold.
g. Allow trace to fully stabilize.
h. Use peak marker function to determine the peak amplitude level.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Conditions

Same as Item 4.3.6.

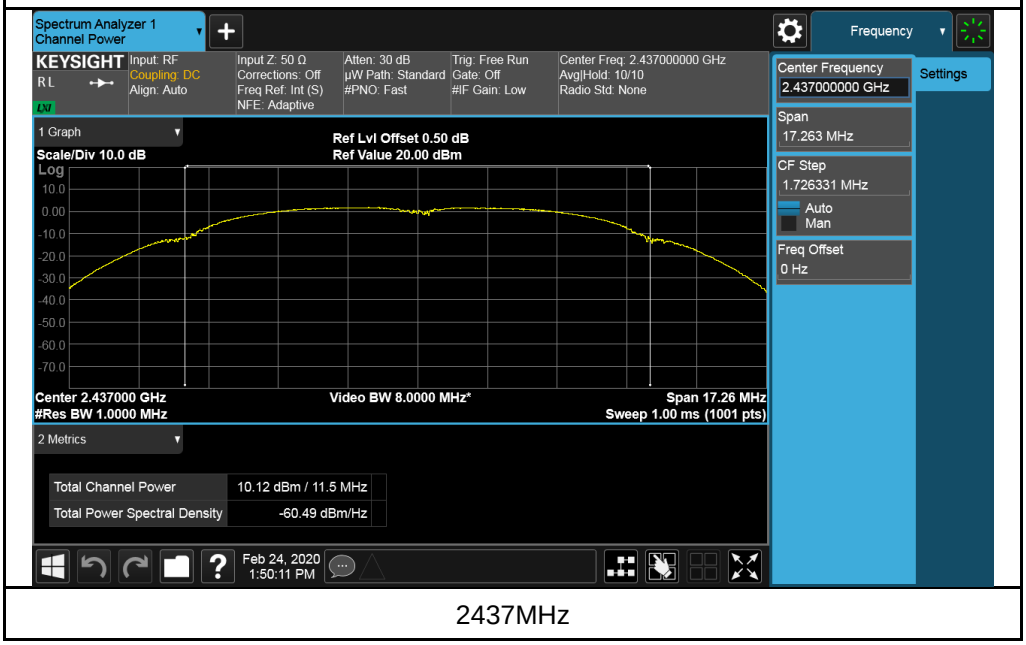
4.3.7 Test Results

802.11b

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
1	2412	9.67	30	Pass
6	2437	10.12	30	Pass
11	2462	11.29	30	Pass

Test Plots:

2412MHz



2437MHz


Spectrum Analyzer 1
Channel Power
KEYSIGHT
RL
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
#PNO: Fast
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold: 10/10
Radio Std: None
Frequency
Center Frequency
2.462000000 GHz
Settings
Span
16.608 MHz
CF Step
1.660797 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 30.50 dB
Scale/Div 10.0 dB
Ref Value 20.00 dBm
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.462000 GHz
#Res BW 1.0000 MHz
Video BW 8.0000 MHz*
Span 16.61 MHz
Sweep 1.00 ms (1001 pts)
2 Metrics
Total Channel Power
11.29 dBm / 11.1 MHz
Total Power Spectral Density
-59.15 dBm/Hz
Feb 24, 2020
1:56:17 PM

2462MHz

802.11g

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
1	2412	10.14	30	Pass
6	2437	11.22	30	Pass
11	2462	11.55	30	Pass

Test Plots:

2412MHz

2437MHz


Spectrum Analyzer 1
Channel Power
Frequency
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
#PNO: Fast
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold: 10/10
Radio Std: None
Center Frequency
2.462000000 GHz
Settings
Span
24.600 MHz
CF Step
2.459956 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 30.50 dB
Scale/Div 10.0 dB
Ref Value 20.00 dBm
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.46200 GHz
#Res BW 1.0000 MHz
Video BW 8.0000 MHz*
Span 24.6 MHz
Sweep 1.00 ms (1001 pts)
2 Metrics
Total Channel Power
11.55 dBm / 16.4 MHz
Total Power Spectral Density
-60.60 dBm/Hz
Feb 24, 2020
2:04:45 PM

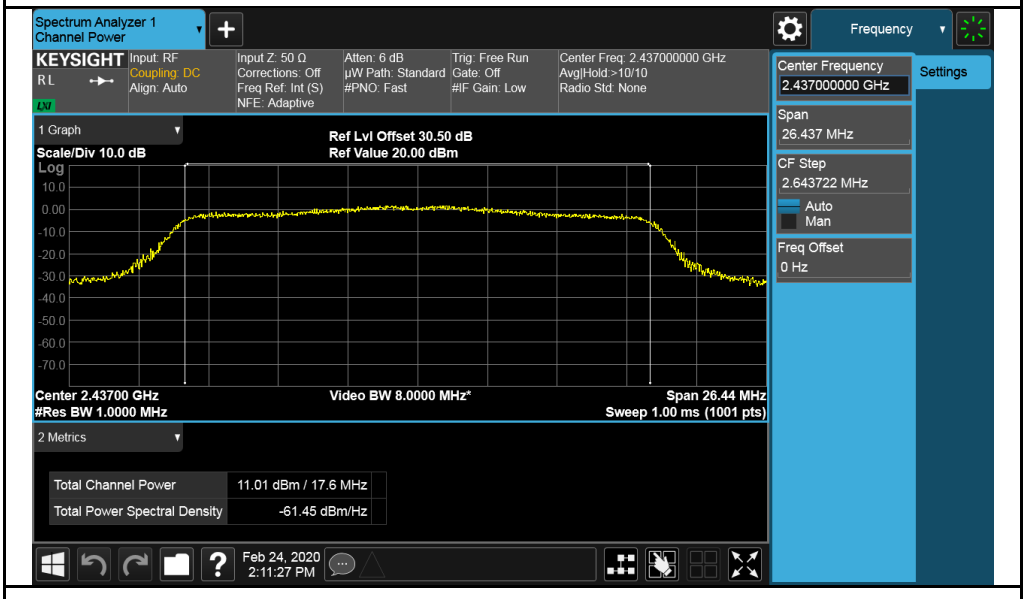
2462MHz

802.11n-HT20

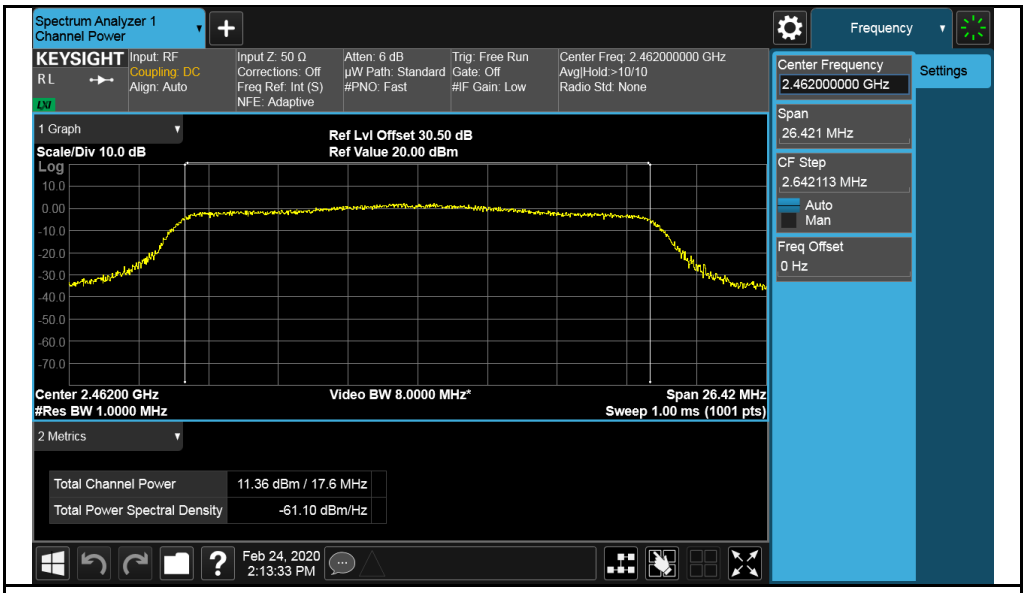
Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
1	2412	10.02	30	Pass
6	2437	11.01	30	Pass
11	2462	11.36	30	Pass

Test Plots:

2412MHz



2437MHz


Spectrum Analyzer 1
Channel Power
Frequency
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
#PNO: Fast
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold:>10/10
Radio Std: None
Center Frequency
2.462000000 GHz
Settings
Span
26.421 MHz
CF Step
2.642113 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 30.50 dB
Scale/Div 10.0 dB
Ref Value 20.00 dBm
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.46200 GHz
#Res BW 1.0000 MHz
Video BW 8.0000 MHz*
Span 26.42 MHz
Sweep 1.00 ms (1001 pts)
2 Metrics
Total Channel Power
11.36 dBm / 17.6 MHz
Total Power Spectral Density
-61.10 dBm/Hz
Feb 24, 2020
2:13:33 PM

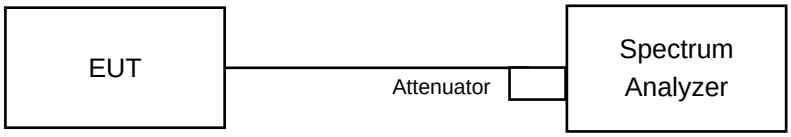
2462MHz

4.4 Power Spectral Density Measurement

4.4.1 Limits of Power Spectral Density Measurement

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedure

a. Set analyzer center frequency to DTS channel center frequency.
b. Set the span to 1.5 times the DTS bandwidth.
c. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d. Set the VBW ≥ 3 × RBW.
e. Detector = peak.
f. Sweep time = auto couple.
g. Trace mode = max hold.
h. Allow trace to fully stabilize.
i. Use the peak marker function to determine the maximum amplitude level within the RBW.

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Condition

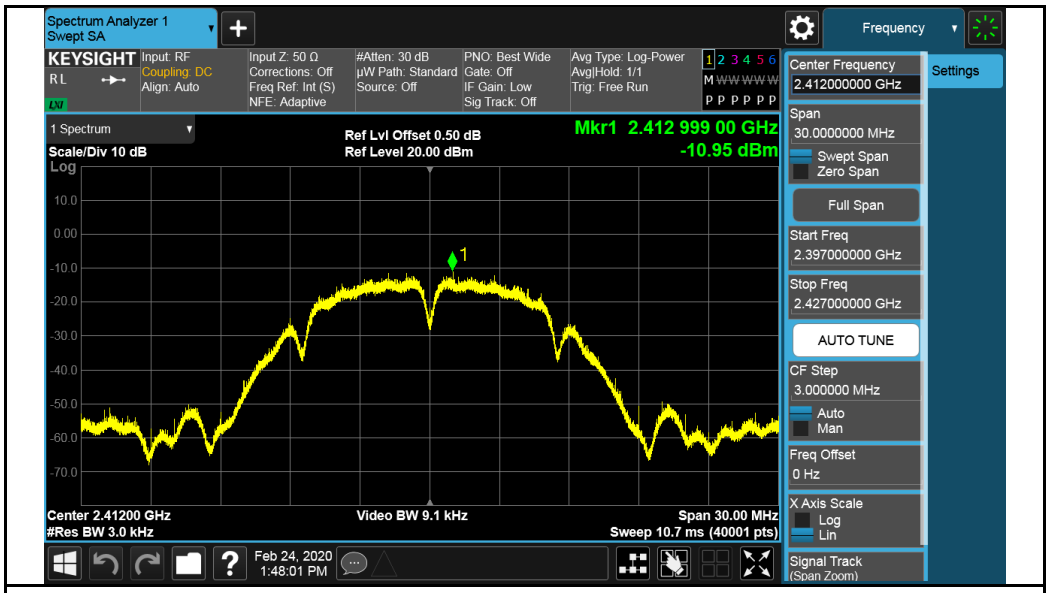
Same as Item 4.3.6

4.4.7 Test Results

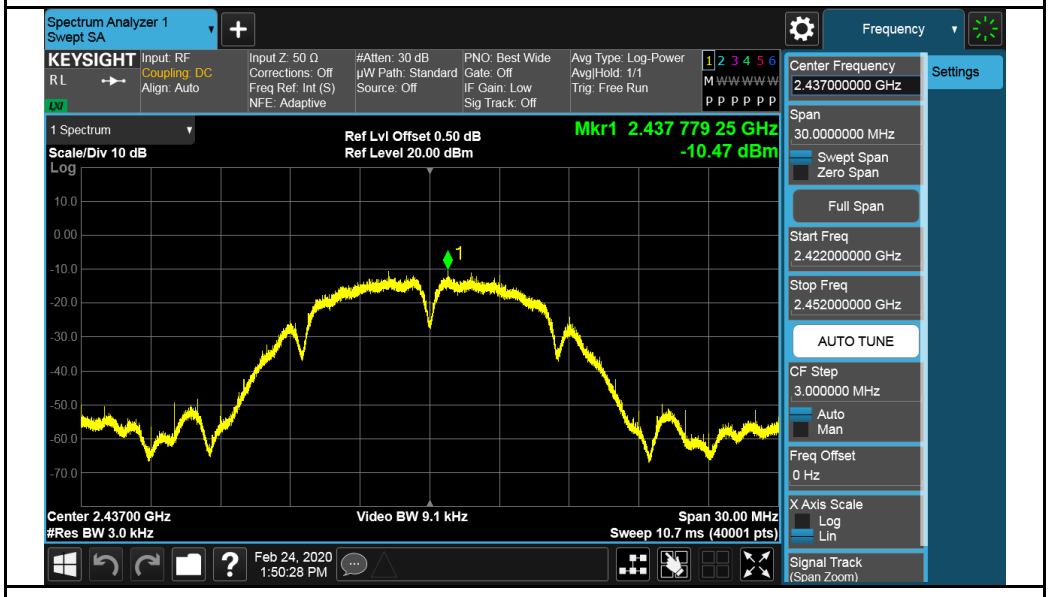
802.11b

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
1	2412	-10.95	8	Pass
6	2437	-10.47	8	Pass
11	2462	-9.08	8	Pass

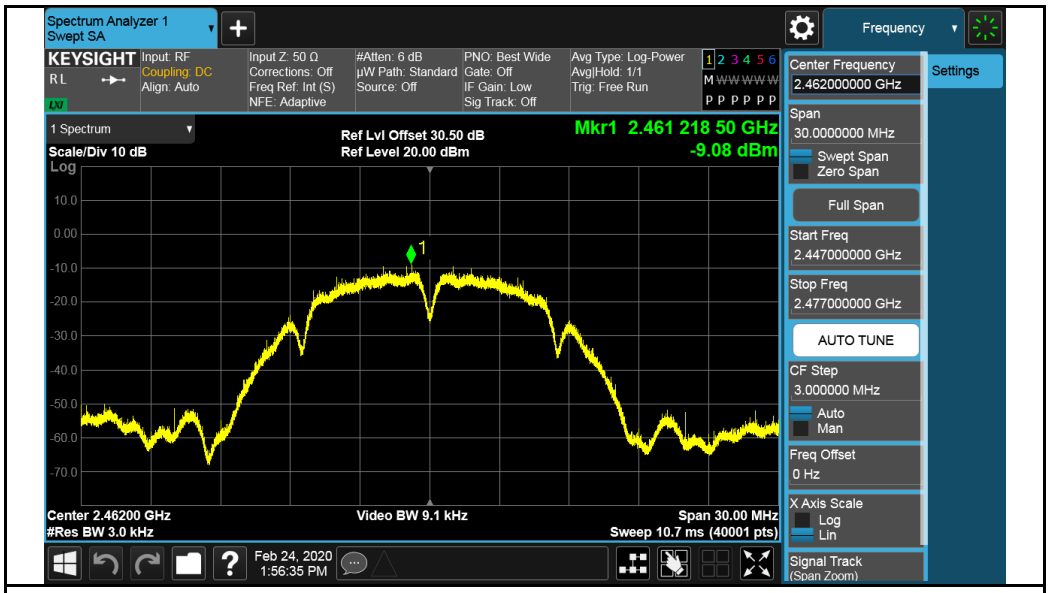
Test Plots:



2412MHz



2437MHz

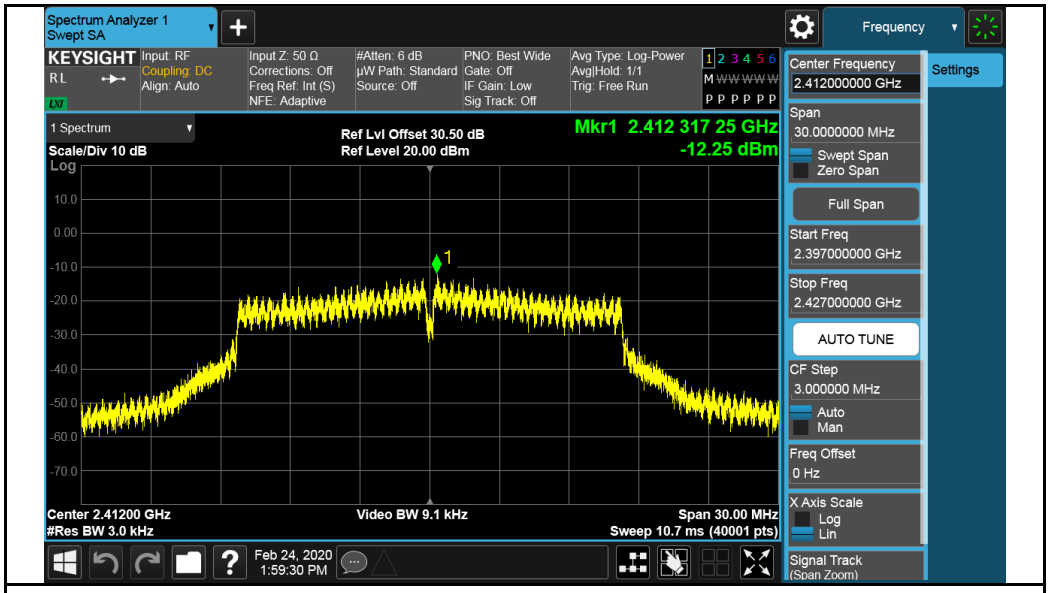

Spectrum Analyzer 1
Swept SA
KEYSIGHT
RL
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
#Atten: 6 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold: 1/1
Trig: Free Run
Frequency
Settings
1 Spectrum
Scale/Div 10 dB
Ref Lvl Offset 30.50 dB
Ref Level 20.00 dBm
Mkr1 2.461 218 50 GHz
-9.08 dBm
Center Frequency
2.462000000 GHz
Span
30.0000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
2.447000000 GHz
Stop Freq
2.477000000 GHz
AUTO TUNE
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)
Center 2.46200 GHz
#Res BW 3.0 kHz
Video BW 9.1 kHz
Span 30.00 MHz
Sweep 10.7 ms (40001 pts)
Feb 24, 2020
1:56:35 PM

2462MHz

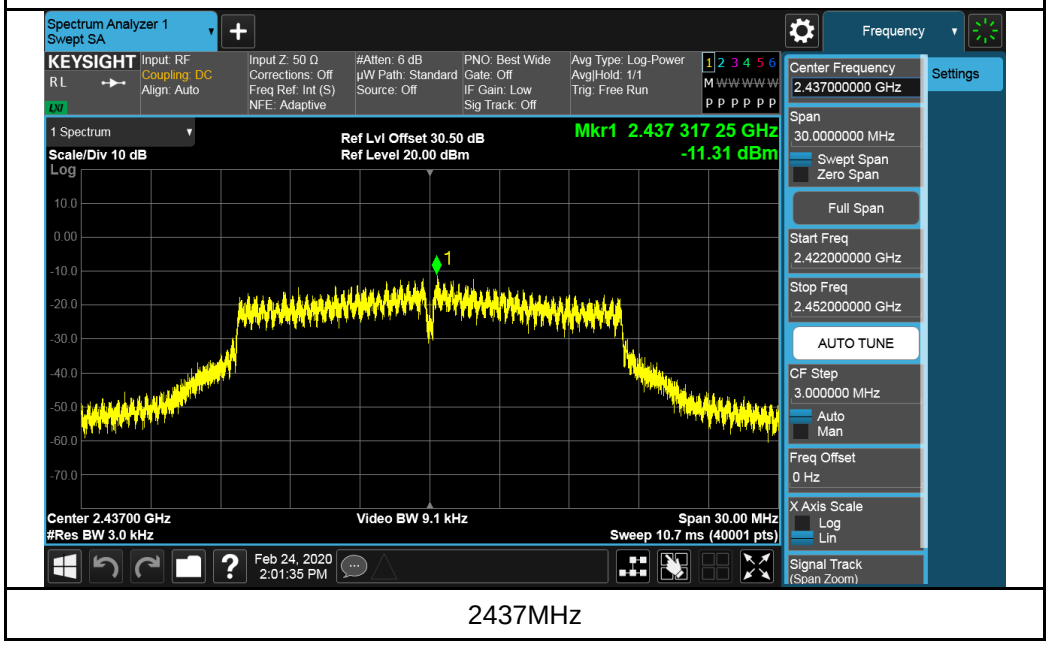
802.11g

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
1	2412	-12.25	8	Pass
6	2437	-11.31	8	Pass
11	2462	-11.06	8	Pass

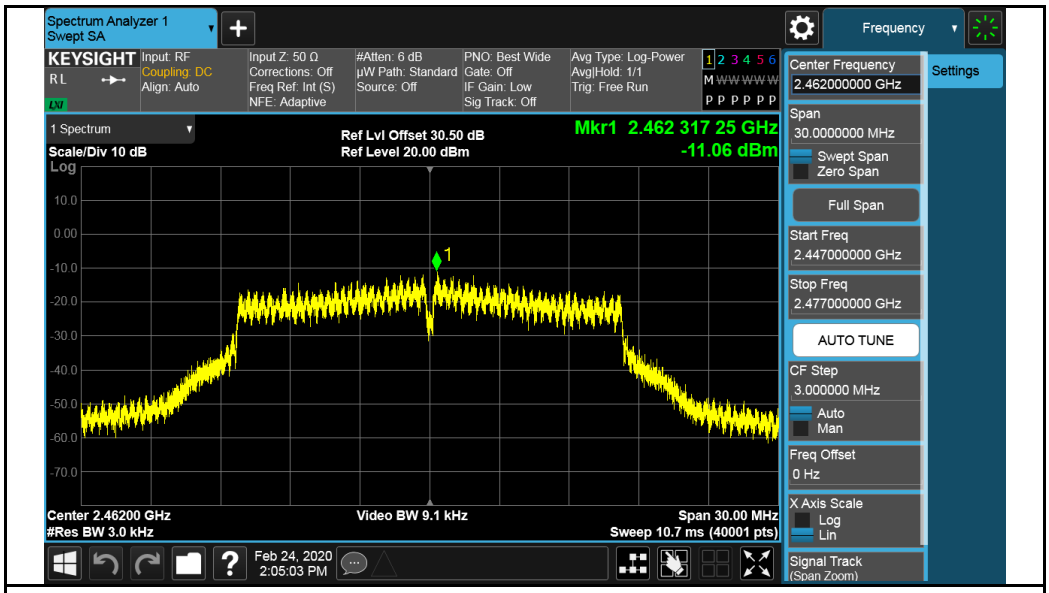
Test Plots:



2412MHz



2437MHz

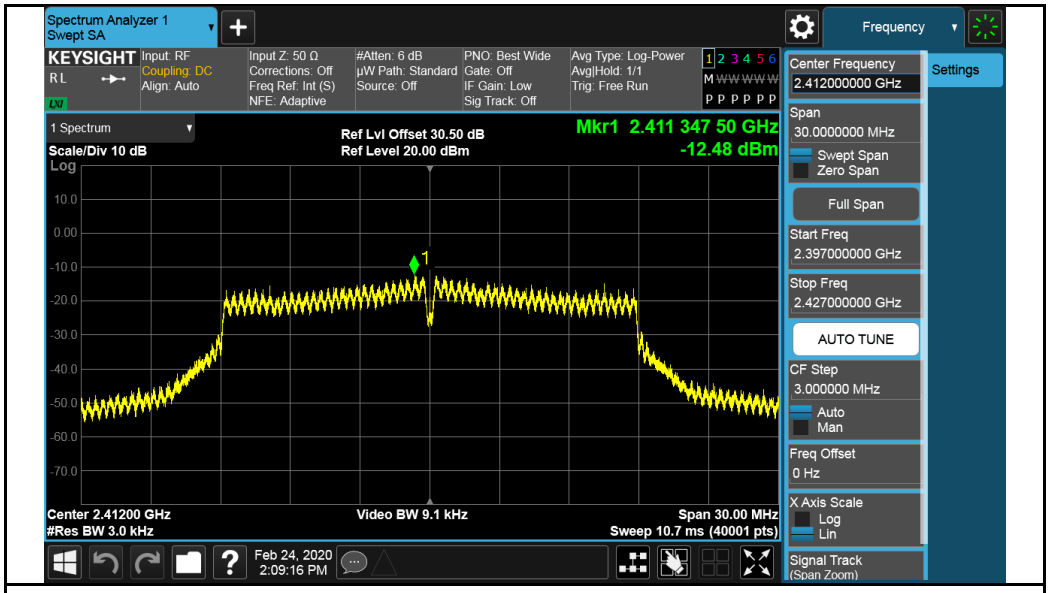

Spectrum Analyzer 1
Swept SA
KEYSIGHT
RL
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
#Atten: 6 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold: 1/1
Trig: Free Run
Frequency
Settings
1 Spectrum
Scale/Div 10 dB
Log
Ref Lvl Offset 30.50 dB
Ref Level 20.00 dBm
Mkr1 2.462 317 25 GHz
-11.06 dBm
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.46200 GHz
#Res BW 3.0 kHz
Video BW 9.1 kHz
Span 30.00 MHz
Sweep 10.7 ms (40001 pts)
Center Frequency
2.462000000 GHz
Span
30.0000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
2.447000000 GHz
Stop Freq
2.477000000 GHz
AUTO TUNE
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)
Feb 24, 2020
2:05:03 PM

2462MHz

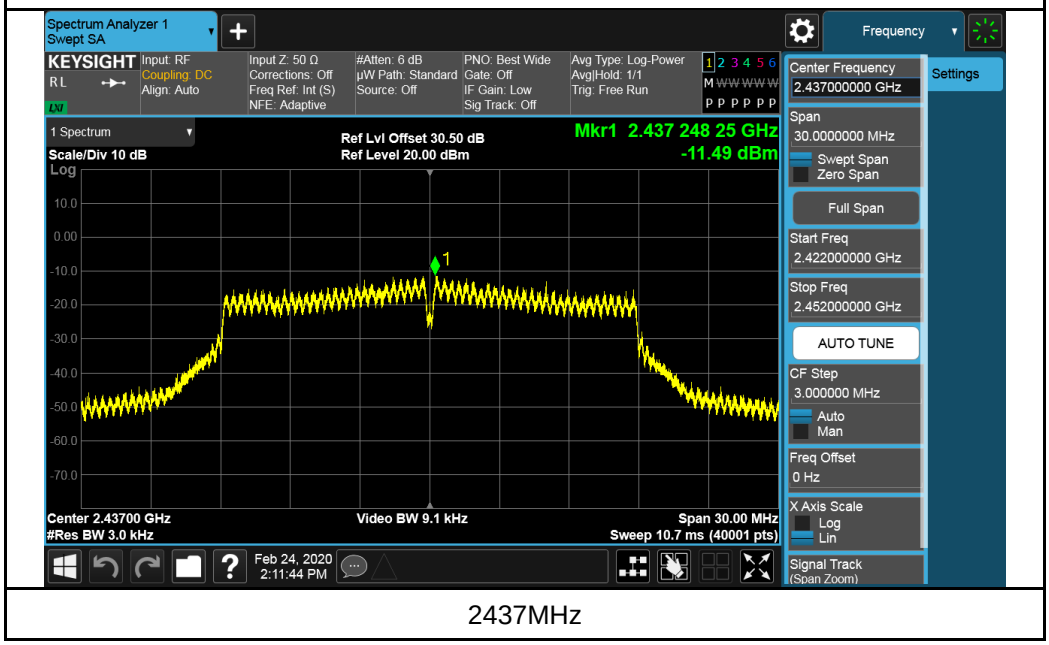
802.11n-HT20

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
1	2412	-12.48	8	Pass
6	2437	-11.49	8	Pass
11	2462	-10.69	8	Pass

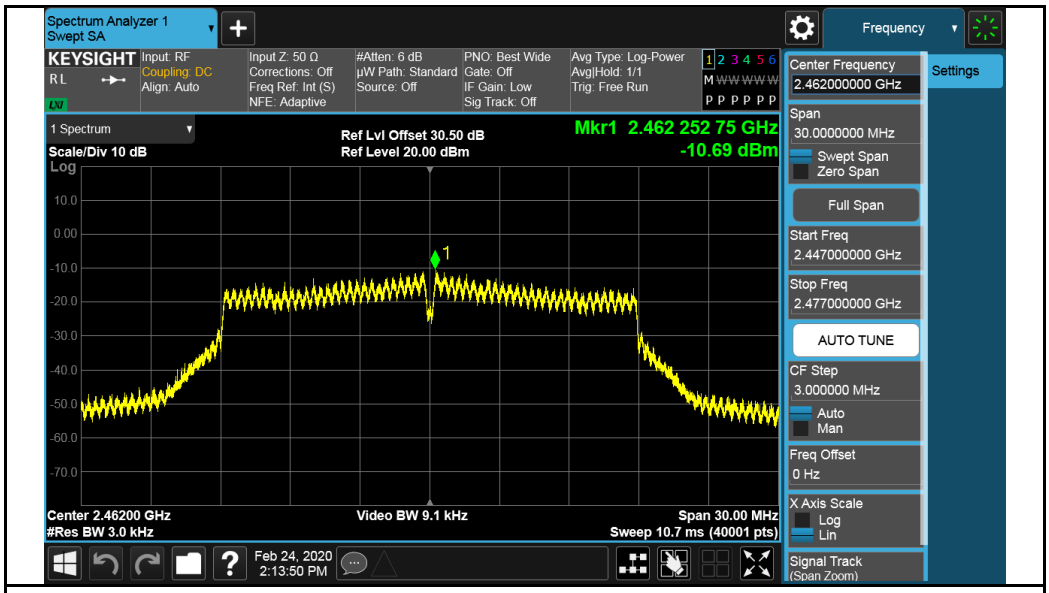
Test Plots:



2412MHz



2437MHz


Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
#Atten: 6 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold: 1/1
Trig: Free Run
Frequency
Settings
1 Spectrum
Scale/Div 10 dB
Ref Lvl Offset 30.50 dB
Ref Level 20.00 dBm
Mkr1 2.462 252 75 GHz
-10.69 dBm
Center Frequency
2.462000000 GHz
Span
30.0000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
2.447000000 GHz
Stop Freq
2.477000000 GHz
AUTO TUNE
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)
Center 2.46200 GHz
#Res BW 3.0 kHz
Video BW 9.1 kHz
Span 30.00 MHz
Sweep 10.7 ms (40001 pts)
Feb 24, 2020
2:13:50 PM

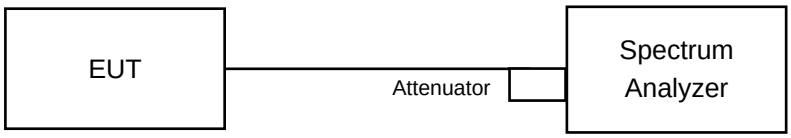
2462MHz

4.5 Conducted Out of Band Emission Measurement

4.5.1 Limits of Conducted Out of Band Emission Measurement

Below 20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

MEASUREMENT PROCEDURE REF

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

MEASUREMENT PROCEDURE OOBE

1. Set RBW = 100 kHz.
2. Set VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

4.5.5 Deviation from Test Standard

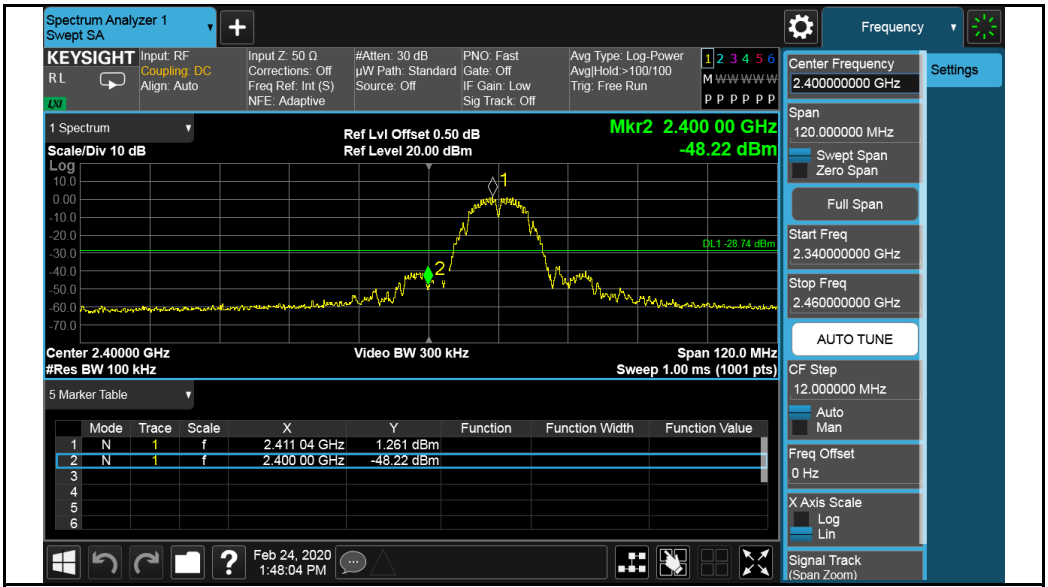
No deviation.

4.5.6 EUT Operating Condition

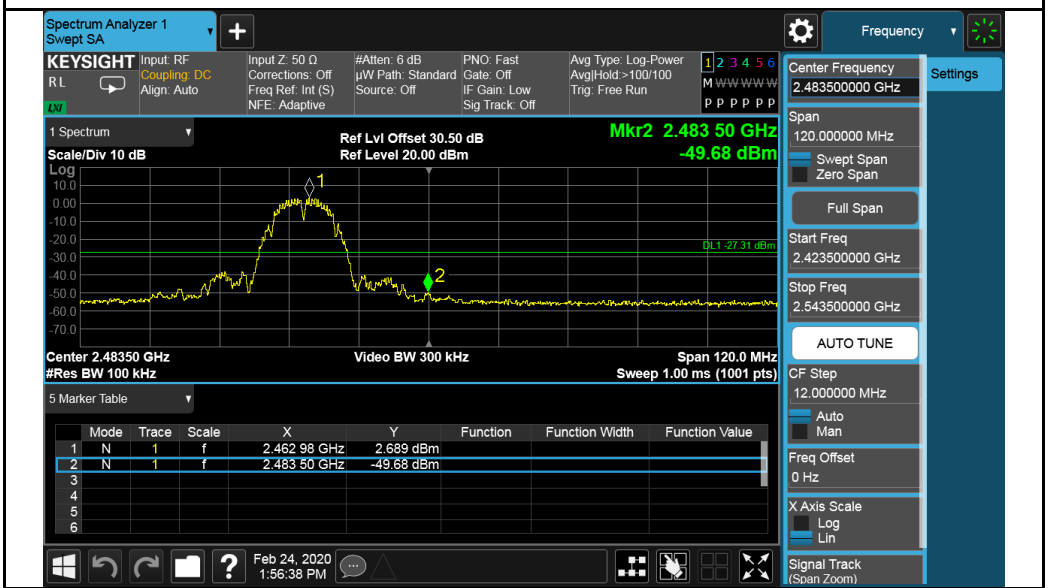
Same as Item 4.3.6

4.5.7 Test Results

802.11b

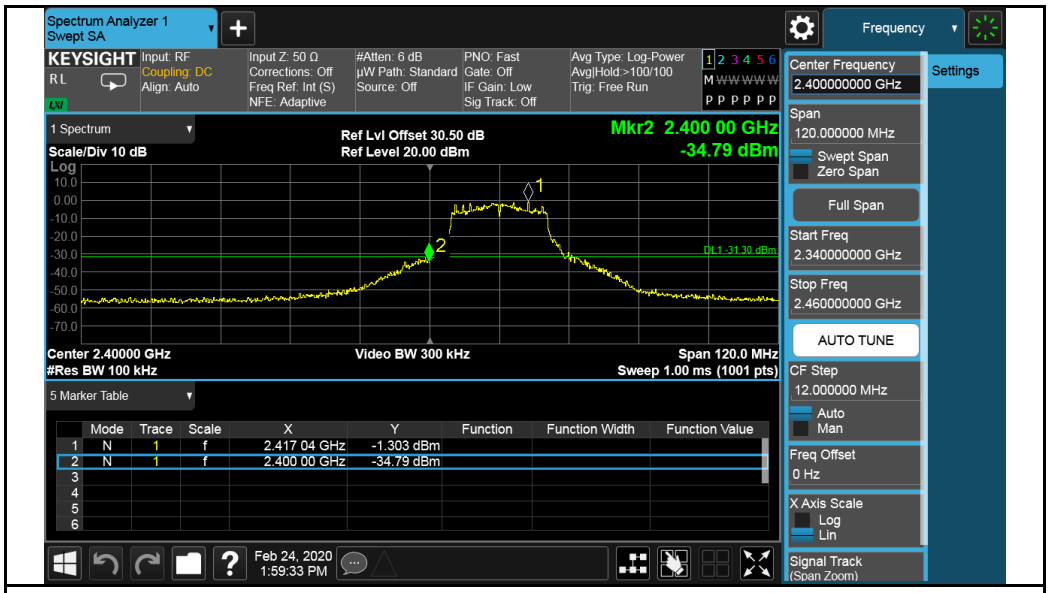


802.11b-2412MHz

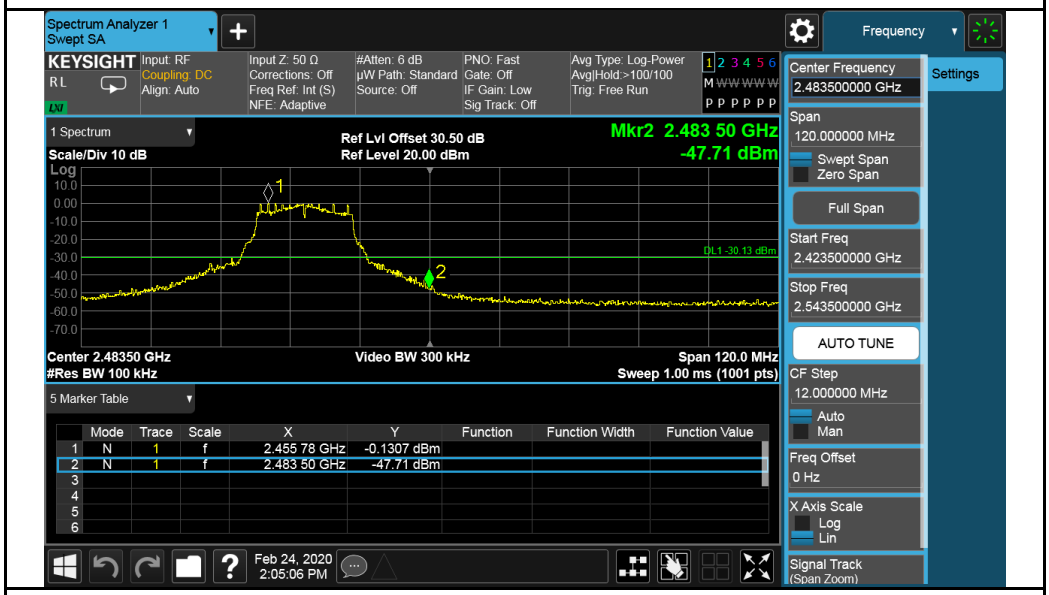


802.11b-2462MHz

802.11g

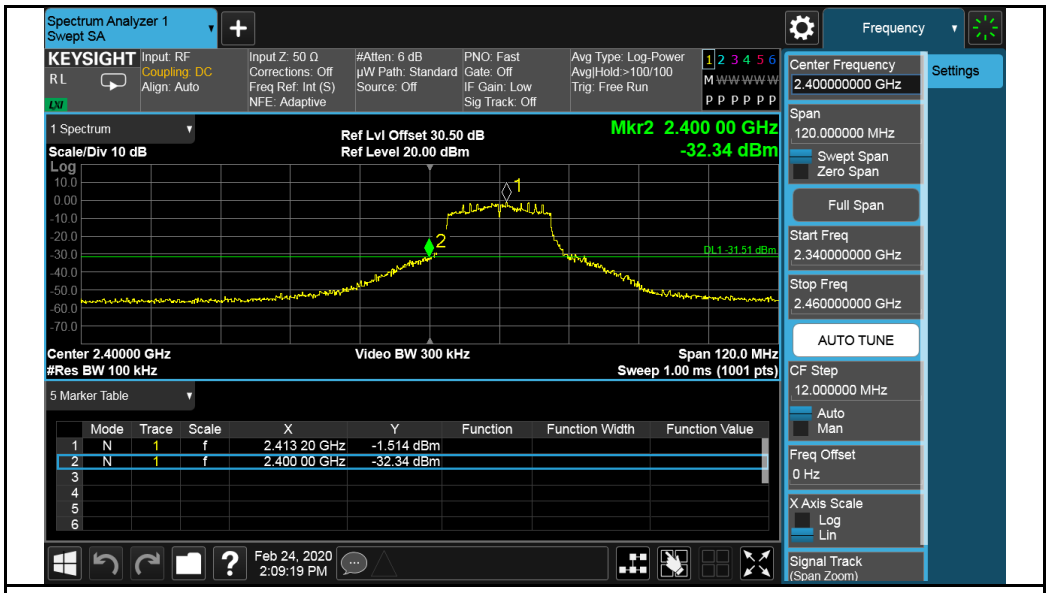


802.11g-2412MHz

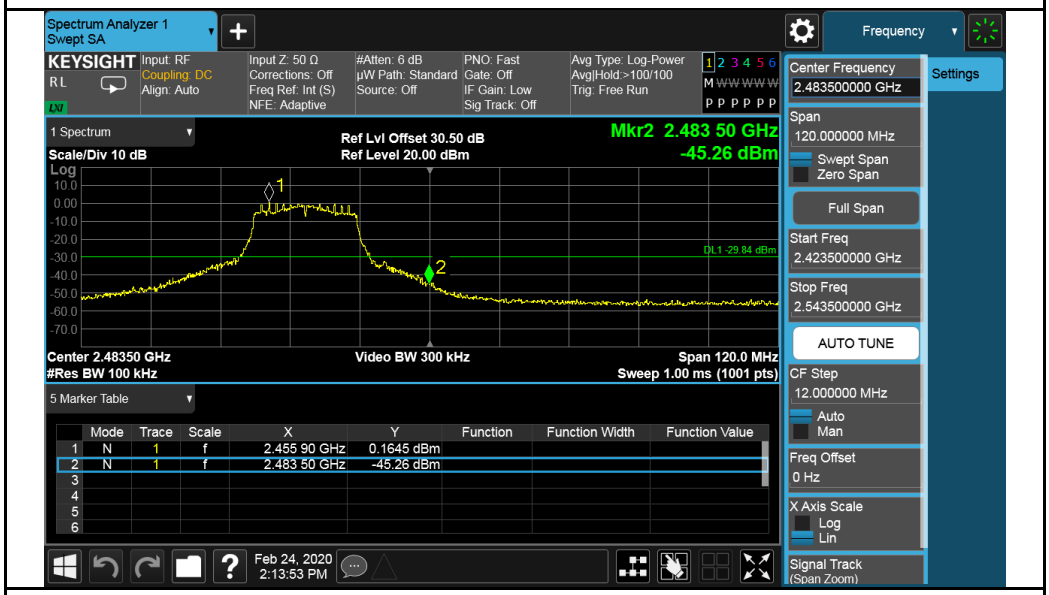


802.11g-2462MHz

802.11n-HT20



802.11n-HT20-2412MHz



802.11n-HT20-2462MHz

5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information on the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following:

Milpitas EMC/RF/Safety/Telecom Lab
775 Montague Expressway, Milpitas, CA 95035
Tel: +1 408 526 1188

Sunnyvale OTA/Bluetooth Lab
1293 Anvilwood Avenue, Sunnyvale, CA 94089
Tel: +1 669 600 5293

Littleton EMC/RF/Safety/Environmental Lab
1 Distribution Center Cir #1, Littleton, MA 01460
Tel: +1 978 486 8880

Email: sales.eaw@us.bureauveritas.com
Web Site: www.cpsusa-bureauveritas.com

The address and road map of all our labs can be found in our web site also.

--- END ---